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FINAL

FEASIBILITY STUDY REPORT

STANDARD CHLORINE OF DELAWARE, INC.
DELAWARE CITY, DELAWARE FACILITY

May 1993

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WESTON
MANAGERS DESIGNERS/CONSULTANTS

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EXECUTIVE SUMMARY

Standard Chlorine of Delaware, Inc. (SCD) is located approximately three miles northeast of Delaware City, Delaware and is bounded to the north and east by property owned by Occidental Chemical Company (formerly Diamond Shamrock Company), to the west by the Air Products Company and to the south by property owned by Star Enterprises, Inc. and Delmarva Power and Light. The SCD facility was constructed in 1965 on farmland purchased from the Diamond Alkali Company which had purchased the land from Tidewater Refinery Company.

SCD plant operations were started in 1966 with the production of chlorinated benzene including chlorobenzene, paradichlorobenzene, orthodichlorobenzene, and lesser amounts of metadichlorobenzene and trichlorobenzene. Although operational production has varied over the years, these chemicals are still the primary products produced at the plant.

As a result of a 1981 release of chlorinated benzene product, the SCD site was evaluated by the U.S. Environmental Protection Agency (EPA), and the Delaware Department of Natural Resources and Environmental Control (DNREC), and based on the results of this evaluation, was placed on the National Priorities List (NPL) in 1985. SCD is required to complete a RI/FS meeting the requirements of the revised National Contingency Plan (NCP) and the Superfund Amendments and Reauthorization Act (SARA) of 1986.

As specified in the Consent Order and Agreement executed on 12 January 1988 (amended 14 November 1988) between the Delaware Department of Natural Resources and Environmental Control (DNREC) and SCD, the Feasibility Study (FS) as presented in this document for the SCD Delaware City, Delaware facility has been performed to develop, screen, and evaluate alternative remedial actions for the site. Alternatives are evaluated in terms of criteria specified under the revised National Contingency Plan (NCP) and current United States Environmental Protection Agency (EPA) Superfund guidance documents.

The national goal of the remedy selection process is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste (40 CFR 300.430). The overall approach followed by this FS consists of the six major steps:

1. Project Scoping - Involves site characterization, development of remedial action objectives, and identification of general response actions.

2. Identification of Applicable or Relevant and Appropriate Environmental and Public Health Requirements (ARARs) - Involves identification of cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal, state, or local law that are either potentially applicable or relevant and appropriate to address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at the site.

3. Identification and Screening of Technologies - The spectrum of available technologies were identified and screened based on effectiveness, implementability and relative cost.

4. Development and Screening of Alternatives - Those technologies that were retained are assembled into comprehensive alternatives that address the site as a whole. These alternative were screened based on effectiveness, implementability, and cost. Retained alternatives were carried into the detailed analysis.

5. Detailed Analysis of Alternatives - Based on criteria specified in the revised NCP and current EPA Superfund guidance.

6. Comparison of alternatives and recommendations.

Project Scoping

The development and evaluation of remedial alternatives is based on the site characterization. Site Characterization involves definition of a site conditions based on the site background, results from the Remedial Investigation (RI) which includes the Baseline Risk Assessment. The RI was submitted as a final document in September 1992.

Summary of Site Conditions

The following paragraphs present the areas of concern as identified by the RI, and discusses the issues concerning these areas.

Information gathered and evaluated during the RI indicates that site-specific chemicals (chlorobenzenes) are present in surficial soils located in the on-site railroad track area. The ballast in the railroad track area reduces the ability of the contaminant to migrate via surface runoff. Additional protection against surface contaminant runoff is provided by the sediment control barriers which were installed in this area and other site drainageways as part of the interim site remedial measures completed by Standard Chlorine.

As indicated by the Baseline Risk Assessment, dermal contact with soils accounts for the majority of potential risks associated with possible exposure to site-related chemicals. Direct contact with soils in the railroad area is limited due to the presence of the railroad ballast. Additionally, human traffic in this area of the site is normally avoided because of the general unsuitable condition, for walking or work activity. Similarly, contact to surface soil contamination present in the on-site eastern drainage ditch will be limited and incidental since this specific area is not normally traversed by workers or visitors.

Subsurface contamination, while present at significant levels in the immediate area of the 1981 release and in the vicinity of the catch basin No. 1 soil, is not being contacted by any receptors. However, subsurface soil contamination in these areas, and other locations at this site, represent a possible continual source of groundwater contamination.

The RI analytical data indicates the soil and sediment quality conditions in some off-site areas, particularly the northwest drainage gully and the unnamed tributary area, have been affected by the 1986 release. The levels of site-related chemicals in sediments of the unnamed tributary area are extremely variable, with the higher concentrations, generally found in the area between the soil dike and the silt fence, a sediment barrier installed subsequent to the 1986 release and maintained at the mouth of the unnamed tributary. Sediment analytical data indicates that this silt fence has limited the migration of contaminants into the Red Lion Creek area and was effective at containing the majority of the spill to the unnamed tributary area.

Potential ecological risks posed by the site-specific chemicals in the northwest gully and the unnamed tributary are expected to be variable due to the nonuniformity of contaminant distribution.

Potential human exposure to site-related chemicals in the unnamed tributary and the northwest drainage gully are expected to be limited since these areas are located on industrially-owned properties which have fences or natural barriers to access. Furthermore, these areas represent unlikely areas of human encounter due to the unstable footing conditions (i.e., steeply sloped and wetlands) that exist at these locations.

The risk of exposure to contaminants in the soil piles and sedimentation basin is not expected to be significant. Previous remedial measures completed by SCD have reduced the potential for direct or indirect exposure to the soil piles. These piles have recently been reconsolidated, from three to two piles, and outfitted with a new cover. This reduces the potential for direct exposure to these materials, and further reduces the ability of the contaminants to migrate due to runoff from these piles. Exposure to the volatilization of contaminants in the soil piles has also been reduced, but not eliminated, by the installation of the soil pile covers.

Exposure to soil contaminants in the off-site effluent area is expected to be minimal, since significant levels of the SCD contaminants were found to be both isolated in occurrence and deep in the soil profile. These contaminated subsurface soils, however, are a source of localized groundwater contamination in this area of the site.

Site-specific chemicals are present in groundwater of the Columbia Formation beneath the SCD site, and the off-site property directly north of the SCD facility. Groundwater samples obtained from Upper Potomac aquifer wells located immediately outside of the boundaries show no detectable levels of site-specific chemicals. The site-specific chemicals in groundwater of the Columbia Formation have migrated to groundwater discharge points along the unnamed tributary and Red Lion Creek. RI data indicates that surface water quality impacts in the unnamed tributary and Red Lion Creek have resulted from the discharge of contaminated groundwater to these surface water bodies. While site contaminants exist in the Columbia Formation, the ingestion of groundwater as a potential future exposure pathway is considered unlikely since potable water is currently supplied to the site and a reliable source of potable groundwater is available off-site.

Development of Alternatives

The technologies that were retained following the identification and screening of technologies were assembled into site-wide alternatives. The assembled alternative were again screened for implementability, effectiveness, and cost. The following summarizes remedial alternatives which have been evaluated:

- Alternative 1 - No Action: Provides the baseline for comparing existing site conditions with those resulting from implementation of other proposed alternatives. Under the no action alternative, no additional remedial action would be performed. Current remedial activities, such as groundwater extraction and treatment, and maintenance of the sedimentation basin and soil piles, would cease.

- Alternative 2 - Containment: Involves implementation of institutional and physical controls aimed at limiting site access to reduce potential future exposure of human receptors. Physical barriers, such as security fences and silt fences, would be installed to limit contaminant migration and direct contact. An enhanced groundwater extraction and treatment, using additional extraction wells and low volume product recovery wells, would be implemented. Readily accessible, highly contaminated surface soils would be removed and stabilized, in situ, with the sediments currently in the basin. Subsurface soils along the western drainage ditch, and the catch basin would also be removed and stabilized. The basin would then be capped and closed. Excavations, and the railroad track area, would be capped.

- Alternative 3 - Closure: Involves installation of an enhanced groundwater interception system to collect groundwater exiting the site. Low volume product recovery wells would also be installed. Removal of readily accessible, highly contaminated surface soils and sediments would be performed. Subsurface soils along the western drainage ditch, and the catch basin would also be removed. The removed materials would undergo ex situ stabilization/ solidification prior to consolidation in a reconstructed lined unit. The sedimentation basin would be reconstructed with a new liner, leachate collection system, and cap prior to final closure. Excavations, and the railroad track area, would be capped. Implementation of the institutional controls as described under Alternative 2 would also be performed.

- Alternative 4 - Thermal Treatment: Involves installation of an enhanced groundwater interception system to collect groundwater exiting the site. Low volume recovery wells for product extraction would be installed. Removal of readily accessible, highly contaminated surface soils and sediments would be performed. Subsurface soils along the western drainage ditch, and the catch basin would also be removed. The removed materials would undergo thermal desorption prior to backfill, or consolidation into the retrofitted (see Alternative 3) sedimentation basin. Excavations, and the railroad track area, would be capped. As an option, all sediments above response levels would be removed and thermally treated. Short term negative impacts would occur from excavation and removal activities in the wetland areas.

- Alternative 5 - Biological Treatment: Involves installation of an enhanced groundwater extraction system to capture groundwater exiting the site. Recovery wells for product extraction would be installed. In situ or ex situ biological treatment would be performed on all surface soils and sediments above the action levels.

Evaluation of Alternatives

In accordance with the NCP and EPA Superfund guidance documents, the following seven criteria were used for evaluation of each of the site alternatives that were selected for detailed analysis and represent the basis for comparing these alternatives:

- Compliance with ARARs.
- Overall Protection of Human Health and the Environment.
- Short-Term Effectiveness.
- Long-Term Effectiveness and Permanence.
- Reduction of Toxicity, Mobility, and Volume of contaminants.
- Implementability.
- Estimated Order of Magnitude (+50% to -30% accuracy) Cost.

Highlights from the detailed/comparative analysis included the following:

- Alternative 1 - No Action: Noted as having major limitations associated with: compliance with ARARs, long-term effectiveness, reduction of toxicity, mobility, or volume, and overall protection of human health and the environment. There are no costs incurred under this alternative.

- Alternative 2 - Containment: Meets or exceeds short-term effectiveness, implementability, and cost criteria. A limitation of this alternative is the lack of sediment removal. ARARs may only be met in the long term. The estimated present worth costs for this alternative is $3.5M.

- Alternative 3 - Closure: Meets all non-cost criteria, including overall protection of human health and the environment, and complies with ARARs. Alternative 3 addresses those media posing the greatest potential for future exposure to site contaminants, while providing several measures, including stabilization, a groundwater interception barrier, and a new liner and leachate collection system for the basin to prevent migration of contaminants. The estimated present worth costs for this alternative is $6.7M.

- Alternative 4 - Thermal Treatment: Represents a higher cost alternative but removes the contaminants from the soils/sediment of concern and intercepts groundwater migration. The estimated present worth costs for this alternativ[e] ranged from $11.7M to $17.6M.

- Alternative 5 - Biological Treatment: Meets all non-cost criteria if performed in situ and enables the plant operation to continue uninterrupted. Implementability, and effectiveness are still under investigation by means of laboratory study. If found feasible, this alternative also removes contaminants and may represent a cost effective alternative for handling contaminated soils/sediments as a stand alone alternative or as a component within one of the other alternatives.

Recommended Alternative

The remedial action alternative selected for this site must address certain statutory requirements of the Superfund Amendments and Reauthorization Act (SARA) of 1986 as follows:

1. Protect human health and the environment.

2. Comply with ARARs.

3. Utilize permanent solutions and alternate treatment technologies to the extent possible.

Based on these statutory requirements, and the information presented in the detailed analysis of alternatives, Alternative 3 (Closure) is recommended for selection as the remedial action alternative. This alternative should be implemented in a phased manner to be most effective and address the primary contaminants' pathways first. This recommendation is supported by the following:

1. Overall Protectiveness of Human Health and the Environment

    - Under this alternative, a groundwater extraction system, including an interceptor trench and low volume product recovery wells, is installed to capture groundwater that currently exits the site into the Unnamed Tributary and Red Lion Creek. This will control contaminant migration into these sensitive receptors, and allow natural attenuation processes to degrade the contaminants in the wetlands.

    - Accessible surface soils, subsurface soils, and sediments containing the highest concentrations of contaminants are removed, treated, and consolidated into the reconstructed sedimentation basin. Those surface soils exceeding response levels that are not removed, are contained by the use of surface caps. This reduces potential future exposure to those materials.

    - Short-term negative impacts to the surrounding environment are minimized. Extensive dredging actions, required for other alternatives, could have negative impacts on the wetland areas.

    - Stabilization and containment of the removed materials, and installation and operation of the enhanced groundwater extraction and treatment system provide permanent remediation for affected media.

2. Comply with ARARs

    - Alternative 3 complies with all identified ARARs. Specifically, 1) surface water quality criteria are addressed through installation of the interceptor trench, 2) land disposal restrictions are addressed by treatment (stabilization) of removed materials prior to containment in the basin, 3) and the minimum technology requirement for construction of a landfill (in this case the basin) will be met by reconstructing the basin with a new liner, leachate collection system and final cover.

3. Utilize Permanent Solutions and Alternative Treatment Technologies to the Extent Practical

- This alternative provides a permanent solution by stabilizing the contaminated soils/sediments and containing them in a lined and capped unit meeting RCRA minimum technology standards.

- Treatment technologies are employed for the recovered groundwater using the plant's wastewater treatment system.

- A treatability study is currently being conducted to determine the viability of using biological treatment either in situ or ex situ for all surface soils and sediments above action levels. As agreed with Delaware DNREC, the results of this study will be presented as an addendum to this FS for DNREC/EPA consideration.

SECTION 1
INTRODUCTION

This document details the activities and results of the Feasibility Study (FS) conducted as part of the Remedial Investigation/Feasibility Study (RI/FS) at the Standard Chlorine of Delaware, Inc. (SCD) Delaware City, Delaware facility. As a result of a 1981 release of chlorinated benzene product, the SCD site was evaluated by the U.S. Environmental Protection Agency (EPA), and the Delaware Department of Natural Resources and Environmental Control (DNREC), and based on the results of this evaluation, was placed on the National Priorities List (NPL) in 1985. SCD is required to complete a RI/FS meeting the requirements of the revised National Contingency Plan (NCP) and the Superfund Amendments and Reauthorization Act (SARA) of 1986. The RI/FS is being conducted under a Consent Order between the DNREC and SCD, dated 12 January 1988 and amended on 14 November 1988. Standard Chlorine of Delaware, Inc. retained the services of Roy F. Weston, Inc. (WESTON) to perform the RI/FS. The Final RI Report, including the Baseline Risk Assessment (BRA), has been submitted to the EPA and the DNREC.

1.1 PURPOSE AND ORGANIZATION OF THE REPORT

This FS has been prepared to identify and screen a variety of remedial technologies that may be feasible for addressing potential risks to the public and the environment posed by contaminated soils, sediments, surface water, and groundwater at the site. From these technologies, potential remedial alternatives were developed, screened, and evaluated in detail. The scope of this FS is based on information obtained during the RI and developed in the baseline risk assessment. This FS includes remedial measures for groundwater, surface water, soils, and sediments.

A detailed site history and setting, as well as current site characteristics, are discussed fully in the RI Report. These topics are summarized in the following subsections of Section 1. Remedial action objectives, including identification of applicable or relevant and appropriate environmental and public health requirements (ARARs) for contaminants of concern at the site and for subsequent remedial actions, are presented in Section 2 of this FS. In Section 3, technologies with the potential to remediate one or more of the environmental media at the site are identified and screened. In Section 4, remedial alternatives are then developed and screened from those technologies retained during the technology screening stage (see Section 4). Section 5 provides a detailed analysis of the developed alternatives. In Section 6, the potential remedial alternatives are summarized and compared.

1.2 SITE BACKGROUND

1.2.1 Site Location and Description

Standard Chlorine of Delaware, Inc. is located approximately three miles northeast of Delaware City, Delaware and is bounded to the north and east by property owned by Occidental Chemical Company (formerly Diamond Shamrock Company), to the west by the Air Products Company and to the south by Governor Lea Road. Figure 1-1 is an index map showing the location of the facility.

The SCD facility was constructed in 1965 on farmland purchased from the Diamond Alkali Company which had purchased the land from Tidewater Refinery Company. The SCD facility was developed as the first industrial facility on the site. Air Products Corporation has developed the property immediately west of the SCD facility, and the Occidental Chemical Company facility is located to the east. SCD is bordered on the south by property owned by Star Enterprises, Inc. and Delmarva Power and Light.

1.2.2 Site Operational History

SCD plant operations were started in 1966 with the production of chlorinated benzene including chlorobenzene, paradichlorobenzene, orthodichlorobenzene, and lesser amounts of metadichlorobenzene and trichlorobenzene. The raw materials (benzene and chlorine) undergo a reaction process under acidic conditions at temperatures below 80°C. Following the reaction process, the continuous stream of chlorinated material is neutralized and sent

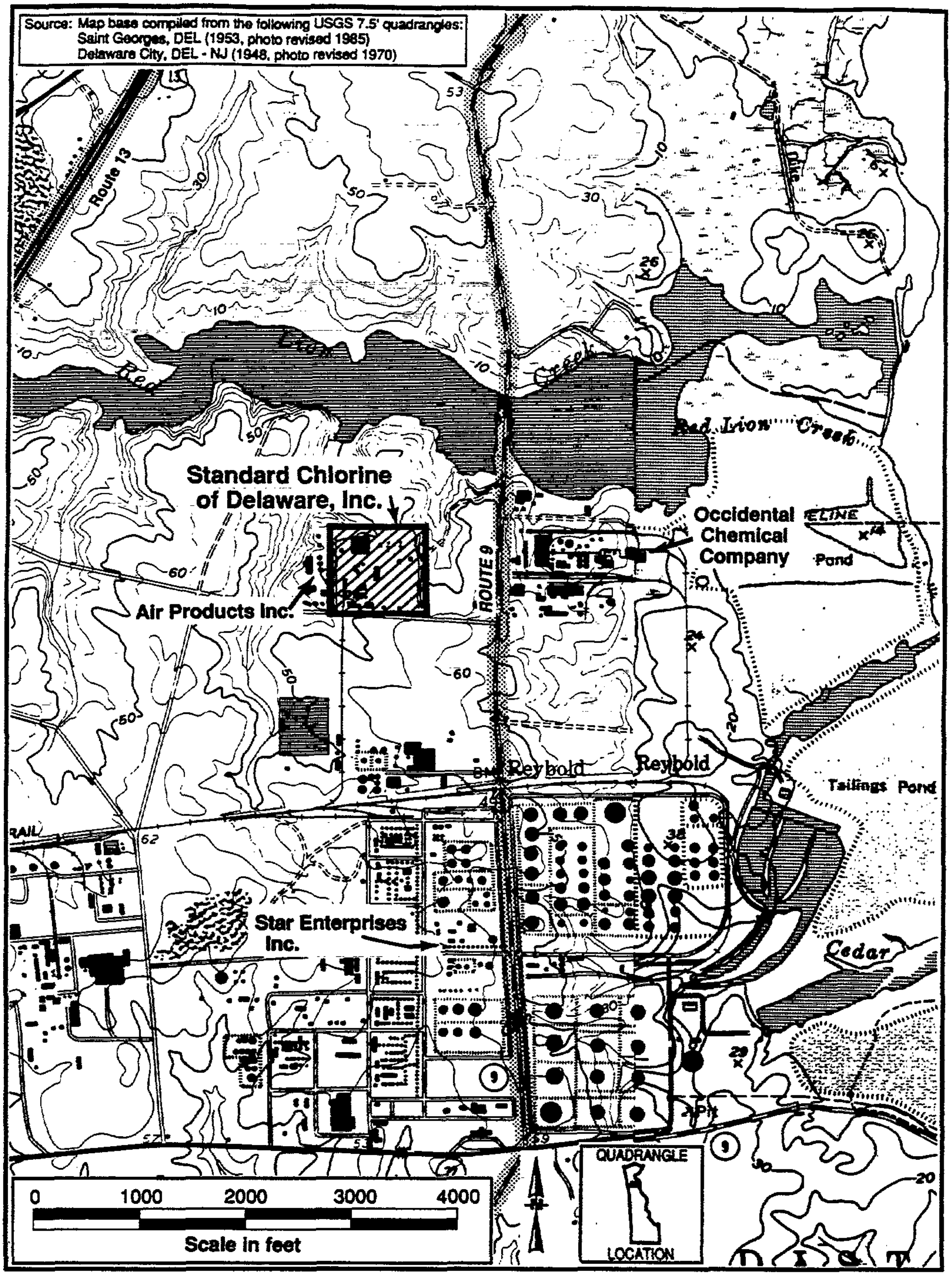

FIGURE 1-1 FACILITY LOCATION
STANDARD CHLORINE OF DELAWARE, INC.
DELAWARE CITY, DELAWARE

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into distillation/crystallization units where the various products are separated and purified under neutral pH conditions and slight vacuum to atmospheric pressure. Hydrochloric acid gas is also a product of the reaction process and is sent to an acid manufacturing unit for production of 20 and 22 degree muriatic acid. All processes employed by SCD are conducted in enclosed vessels.

The facility was expanded in the early 1970s for increased production of monochlorobenzene, dichlorobenzene, purified trichlorobenzene and for the chlorination of nitrobenzene. Nitrobenzene chlorination processes consisted of a reacting system, an acid manufacturing unit and a neutralizing and distillation unit to purify metachloronitrobenzene. In the late 1970's the process was shut down and most of the equipment was converted for chlorobenzene production. Production capacity of the facility was again increased in the late 1970's. Since that time, SCD has continuously produced chlorobenzene, paradichlorobenzene, purified 1,2,4-trichlorobenzene, technical trichlorobenzene and some functional insulating fluids based on chlorobenzene. The more heavily chlorinated compounds exhibit extremely low volatility and high thermal stability.

In the mid 1980's a calcium chloride plant was put on line. This system utilizes excess muriatic acid and limestone for the production of a 35% calcium chloride solution.

Operational controls at SCD include a wastewater treatment plant, release containment pads, release containment areas, continuous monitoring of chlorine unloading facilities, a tank inspection program, and periodic inspections for process and manufacturing safety. In 1977 SCD constructed and placed into operation, a treatment plant for process wastewaters to meet National Pollution Discharge Elimination System (NPDES) permit requirements. In the early 1980's, SCD installed a release containment pad under the railroad loading facility to augment the release contaminant truck loading facilities installed in the late 1970's. In the middle 1980's, SCD increased the capacity of the containment areas for storage tanks to 110% of the largest tank, plus six inches free board. In 1986 a groundwater recovery system was installed and placed on-line to convey recovered groundwater to the on-site wastewater treatment plant as approved by DNREC.

1.3 ENVIRONMENTAL SETTING

1.3.1 Site Topography and Surface Drainage

The SCD property is located on a relatively flat parcel of land, approximately 50 feet above mean sea level. Surface elevations decrease rapidly approximately 1000 feet north of the site approaching sea level at Red Lion Creek.

Local surface drainage on the plant property is generally towards the east and west. Westerly surface drainage in the railroad track area is directed to the north and south with eventual discharge to the unnamed tributary of Red Lion Creek. Facility surface water that drains to the east is collected in the eastern drainage ditch with eventual discharge to Red Lion Creek. Surface water in Red Lion Creek ultimately discharges through a tide gate to the Delaware River approximately 6,000 feet downstream of the SCD facility. Figure 1-2 presents the principal surface drainage pathways for the facility and surrounding properties.

1.3.2 Geology

The SCD facility is directly underlain by unconsolidated deposits of the Columbia Formation, as shown on the geologic cross-section through the site presented in Figure 1-3. This formation is principally comprised of sand and gravel with occasional small lenses or stringers of silt/clay. In the RI/FS study area, the thickness of the Columbia Formation ranges from approximately 41 to 74 ft.

Subsurface lithologic sampling conducted during the RI and in previous site investigations indicate that the Merchantville Formation underlies the Columbia Formation at the SCD facility, except in the central portion of the site. The Merchantville Formation is described as a micaceous clay to silty/sandy clay.

The removal of the Merchantville Formation from the central portion of the SCD site has created a structural low area or "trough" on the surface represented by the top of the Merchantville, or the Potomac Formation (where the Merchantville is absent). The lowest

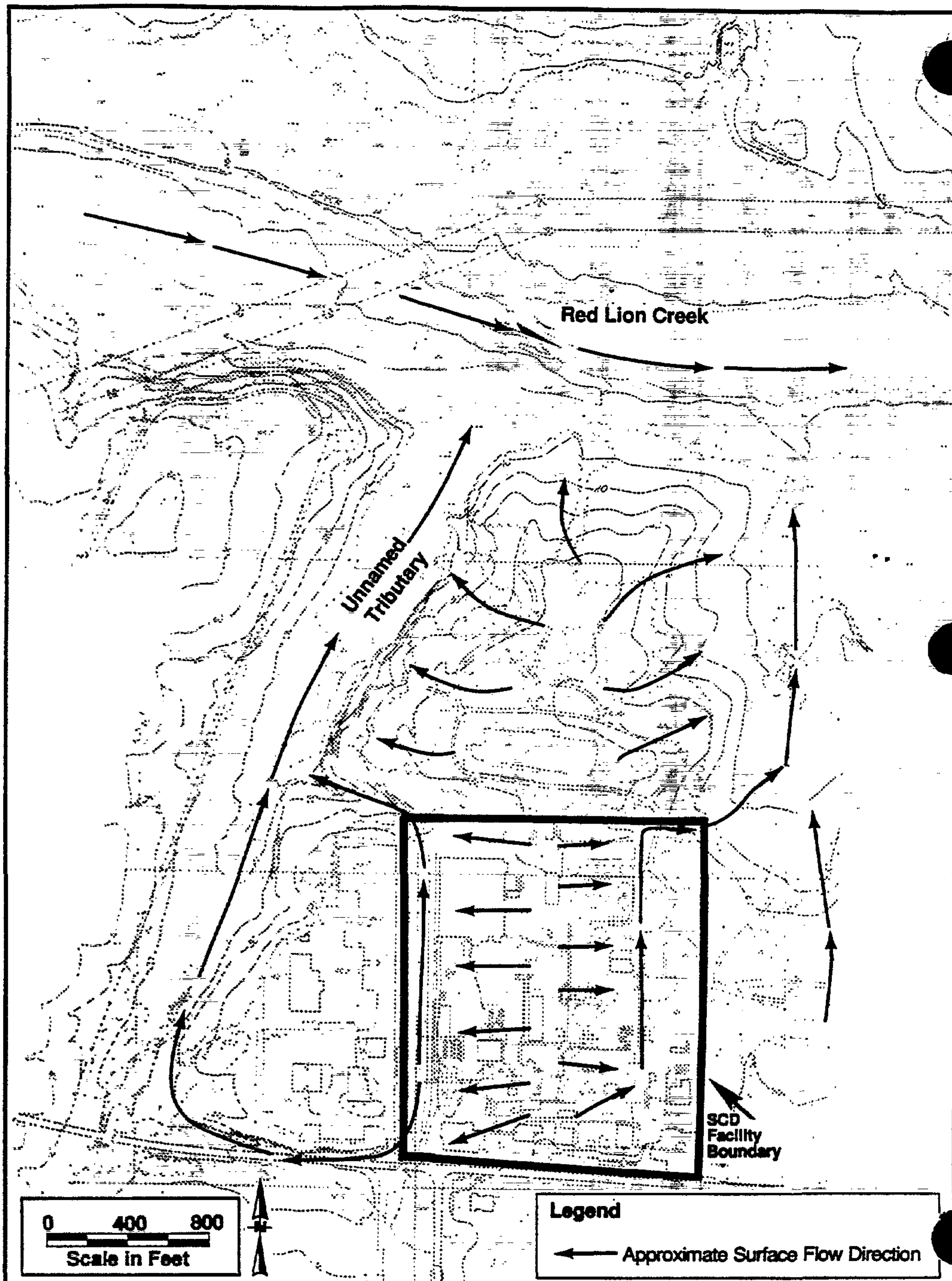

FIGURE 1-2 APPROXIMATE SURFACE DRAINAGE PATTERNS
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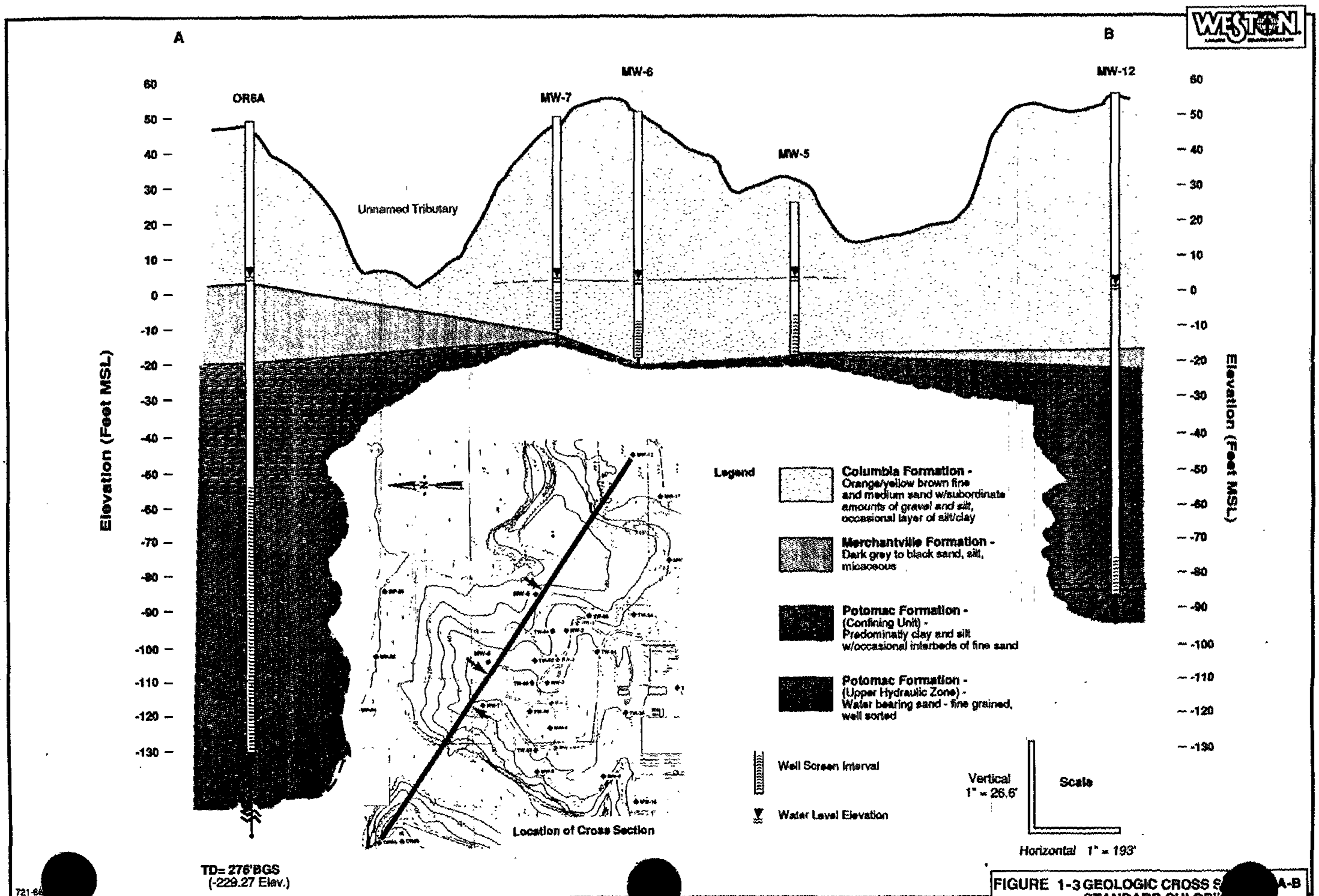

FIGURE 1-3 GEOLOGIC CROSS S[illegible] A-B
STANDARD CHLORI[illegible]
DELAWARE, INC.

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area of the "trough" is located in the eastern portion of the SCD facility. The longitudinal axis of this "trough" trends in a general north-south direction.

The Potomac Formation underlies the Merchantville Formation and the Columbia Formation, where the Merchantville is absent. The upper portion of the Potomac Formation in the RI/FS study area is comprised of interbeds of clay, silt, and sand. Lithologic data obtained in the RI and from previous investigations suggest the presence and continuity of Potomac Formation clays beneath the Columbia and Merchantville Formations in the RI/FS study area. Thickness of the confining unit (i.e., Merchantville Formation and upper portion of the Potomac Formation) lying stratigraphically between the Columbia Formation, and the first monitorable water-bearing zone in the Potomac (referred to as the upper Potomac aquifer) is on the order of 60-70 feet based on lithologic sampling performed in the RI.

1.3.3 Hydrogeology

The uppermost groundwater system at the SCD site is contained in the Columbia Formation. Depth to the water table at the site monitor wells ranges from approximately 37 to 50 feet below ground surface (based on August 1990 readings taken during the RI). Groundwater flow within the Columbia Formation at the SCD site is predominantly to the north towards Red Lion Creek and the unnamed tributary, which are discharge points for groundwater in the Columbia Formation. Vertical migration of groundwater from the Columbia Formation to the upper Potomac aquifer is restricted by the underlying confining geologic unit.

Based on hydraulic data obtained in the RI, groundwater flow in the upper Potomac aquifer at the SCD site is generally in a southeasterly direction. Pump testing of the upper Potomac aquifer during the RI demonstrated the low vertical permeability of the confining unit in the study area. Water level monitoring data collected during the pump test showed that a hydraulic connection (i.e., "window" in the confining unit) between the Columbia Formation and the upper Potomac aquifer does not appear to exist in the RI/FS study area.

1.4 PREVIOUS SITE INVESTIGATIONS AND REMEDIAL RESPONSES

1.4.1 Introduction

This section discusses site investigative and remediation activities performed by SCD in association with the accidental release of chlorinated benzene products that occurred at the facility in 1981 and 1986.

1.4.2 1981 Release and Related Remedial Activities

A release of industrial grade monochlorobenzene (MCB) occurred at the SCD on 16 September 1981. The release occurred while filling a railroad tank car and the chemical was discharged to the ground around the siding. The estimated volume of MCB released was as much as 5,000 gallons. Some of the released chemical ran off in surface ditches toward the unnamed tributary to Red Lion Creek. Figure 1-4 shows the 1981 release flow pathways taken by the released chemical.

SCD took the following actions in response to this release:

- SCD took prompt action to contain and recover the surface runoff component of the release in order to minimize the discharge of MCB to the surface waters of Red Lion Creek.
- Under the supervision of the DNREC, SCD excavated and disposed of MCB-contaminated surface soils at an off-site permitted commercial facility.
- SCD conducted a limited subsurface test program in the vicinity of the release in order to determine the extent of chemicals in the subsurface. Based upon this investigation, the DNREC and SCD concluded that the potential existed for MCB to migrate to the groundwater underlying the site.

WESTON was retained by SCD to provide technical services for assessing the environmental impact of the release, and developing corrective actions. SCD and WESTON subsequently completed the following remedial investigations and corrective actions:

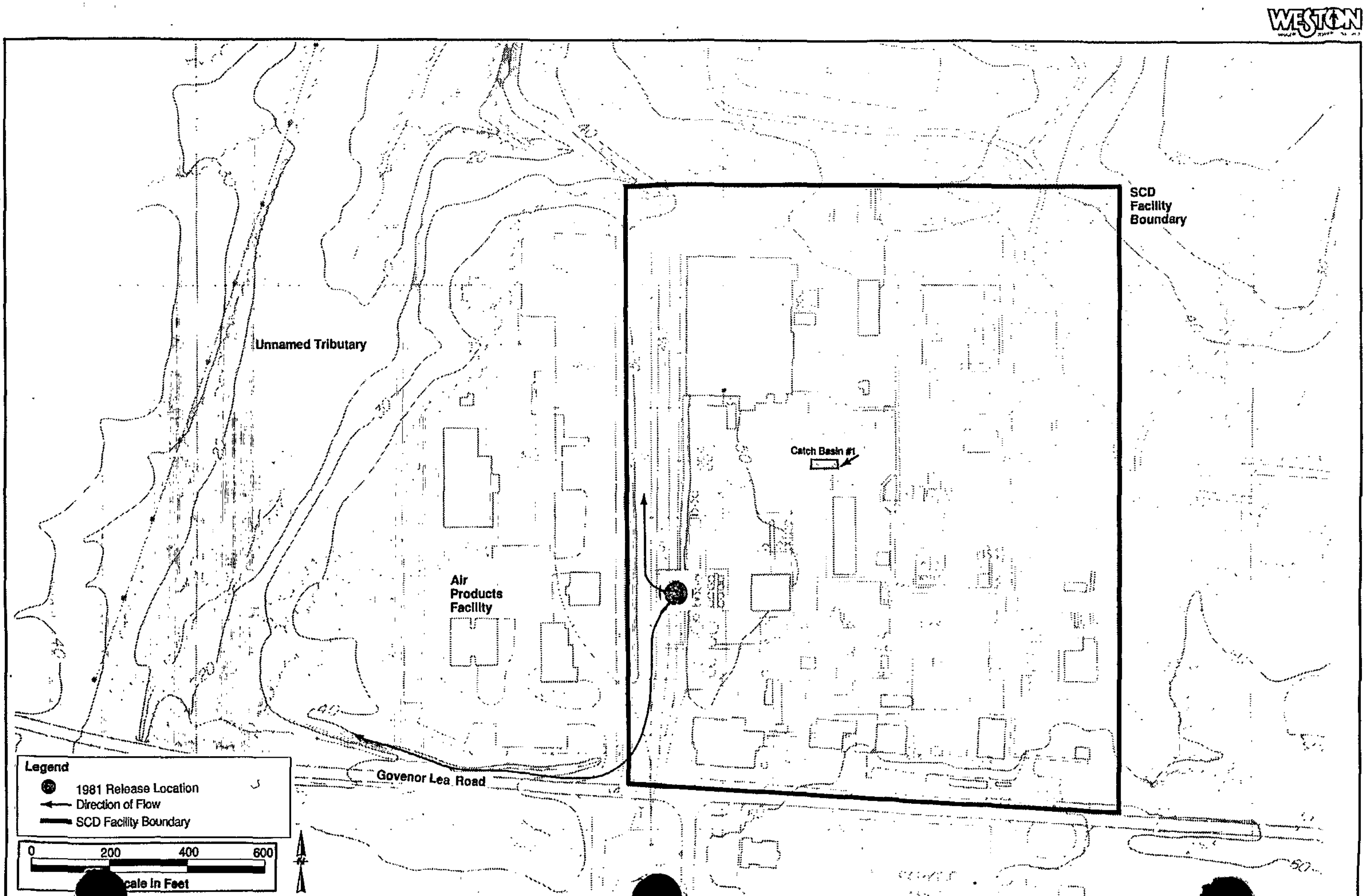

FIGURE 1-4 1981 RELEASE FLO WAYS
STANDARD CHLORINE F DELAWARE, INC.

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- WESTON performed a field investigation and assessment of the release, which included the installation of ten on-site groundwater monitoring wells. The findings of this assessment were documented in a June 25, 1982 report entitled "Hydrogeological and Concept Engineering Evaluation of Remedial Actions for a Monochlorobenzene Release".

- Groundwater sampling and analysis performed during the field investigation indicated the presence of other chlorinated benzene products in groundwater. Although the DNREC has been notified of other releases on-site, the primary source for the other chlorinated benzene products was attributed to the leaking of a process drainage catch basin (catch basin no. 1), which had occurred and was remediated in March of 1976. The location of catch basin no. 1 (CB1) is shown on Figure 1-4. CB1 functions as a settling unit, fed by a underground process sewer line, in which the heavier chlorinated benzenes settle and the lighter water components float. The settled chlorinated benzenes are recycled to the process and the lighter water components are discharged to the wastewater treatment unit. Following detection of the leak, the basin was excavated and replaced, along with a portion of the underground line discharging into it. Annual inspections of the integrity of the new CB1 are conducted by SCD and recorded.

- WESTON completed a second phase of the investigation to determine the on-site and off-site extent of MCB and other chlorinated benzenes identified during the initial investigation. This work included the installation of ten additional groundwater monitor wells. The results of this work were documented in a 29 July 1983, report entitled "Hydrogeological and Concept Engineering Evaluation of Groundwater Contamination". This report recommended the implementation of a hydrodynamic barrier and groundwater recovery system with treatment of the recovered groundwater using air stripping.

- WESTON recommended that an expansion of SCD's existing industrial wastewater treatment plant would be required for treatment of the recovered groundwater. The expansion would include: 1) an air stripping tower to remove groundwater contaminants prior to mixing with the process wastewater streams, and 2) an additional clarifier/tertiary sand filter to accommodate the increased combined flow.

- WESTON completed an evaluation of control options for air emissions from the proposed air stripping unit associated with the groundwater treatment system. The results of this evaluation were presented in a 14 September 1983 report entitled "An Assessment of the Ambient Air Quality Impact of the Controlled Air Emissions from Standard Chlorine's Proposed Air Stripping Tower". The selected control strategy recommended that the air stripping exhaust gases be vented to an existing process boiler.

- WESTON completed an evaluation of increased effluent flow from SCD's NPDES outfall resulting from the groundwater treatment process. The results of the WESTON evaluation were presented in a September 1984 report entitled, "Feasibility Study and Final Design Report, Standard Chlorine of Delaware, Inc."

- Implementation of the recommendations of the WESTON studies, which required issuance of various permits, was conducted by SCD. This included modifications to the process boiler permit to include venting of air stripper vapors to the process boiler. An emergency construction permit for the treatment plant modifications was issued by the Delaware River Basin Commission (DRBC) on 18 December 1984. The NPDES permit for the treatment plant modifications and increased discharge flow (from 0.48 to 1.0 million gallons per day) was issued by the DNREC on 21 January 1985. The DRBC approved the DNREC withdrawal permits for the recovery wells on 30 January 1985.

- A groundwater recovery and treatment system went on-line at the SCD facility in 1986.

- Monitoring of the groundwater recovery and treatment system is being performed and has been documented in quarterly reports to the DNREC since 1986.

- The current NPDES permit regulates the effluent discharge to the Delaware River to an average flow of 0.68 million gallons per day and limits the concentrations of benzene and benzene derivatives, biological oxygen demand, total suspended solids and selected metals. The NPDES permit was issued in September 1989 and expires in September 1994.

1.4.3 1986 Release and Related Remedial Activities

Approximately 400,000 gallons of paradichlorobenzene (DCB) and 169,000 gallons of trichlorobenzene (TCB) were released during an accident at the SCD plant on 5 January 1986. The release occurred when the integrity of a 375,000-gallon tank containing heated DCB failed. The tank collapsed and damaged three nearby tanks containing DCB and TCB. Damage sustained by these three tanks released a portion of these tanks, too. The initial tank failure was blamed on weakened tank welds. Since the products had been contained in heated tanks at the time of the release, both products were in liquid form. DCB and TCB are solids at standard temperature and pressure. Cold outside temperatures (15-20°F) at the time of the release caused the products to solidify upon contacting the ground surface. This solidification helped to minimize dispersal of the chemicals in two ways:

1. It limited lateral spread of the DCB and TCB, as the chemicals contacting the ground solidified. The remaining warm liquid phase flowed until it, too, contacted the ground surface and solidified.

2. It limited vertical spread of the DCB and TCB into the subsurface as the ground was frozen. This limited penetration also facilitated an expeditious surface cleanup of solidified, pure product especially in the plant area.

The released products followed two pathways of flow, one easterly, onto asphalted plant property and one northerly, along the railroad tracks. Figure 1-5 shows the flow pathways followed by the 1986 release. The flow onto the plant property was primarily contained on asphalt covered areas, where most of it solidified. A minimal amount which flowed to a drainage ditch along the eastern plant boundary, flowed northerly along the ditch for a short distance, and dissipated before it reached the plant boundary. The portion of the release which flowed along the railroad tracks continued down a steep drainage ditch to a small, unnamed tributary to Red Lion Creek. The released products spread across the tributary channel and continued downstream to the area of confluence with Red Lion Creek. At the time of the release the tide in Red Lion Creek was high and ebbing; consequently, some of the chemical migrated from the mouth of the tributary upstream along Red Lion Creek approximately 500 feet, hugging the southern shoreline. Both compounds are heavier than water, and consequently, both sank to the bottom of the water column. After cooling, the compounds stratified. The DCB formed a hard, flat, crystalline formation, and the TCB remained as a dense liquid lying immediately above and below the DCB.

SCD took the following immediate action in response to this release:

- SCD took prompt action to contain the chemicals in order to prevent further discharge into Red Lion Creek; control measures included booms, dikes, and a filter fabric fence.

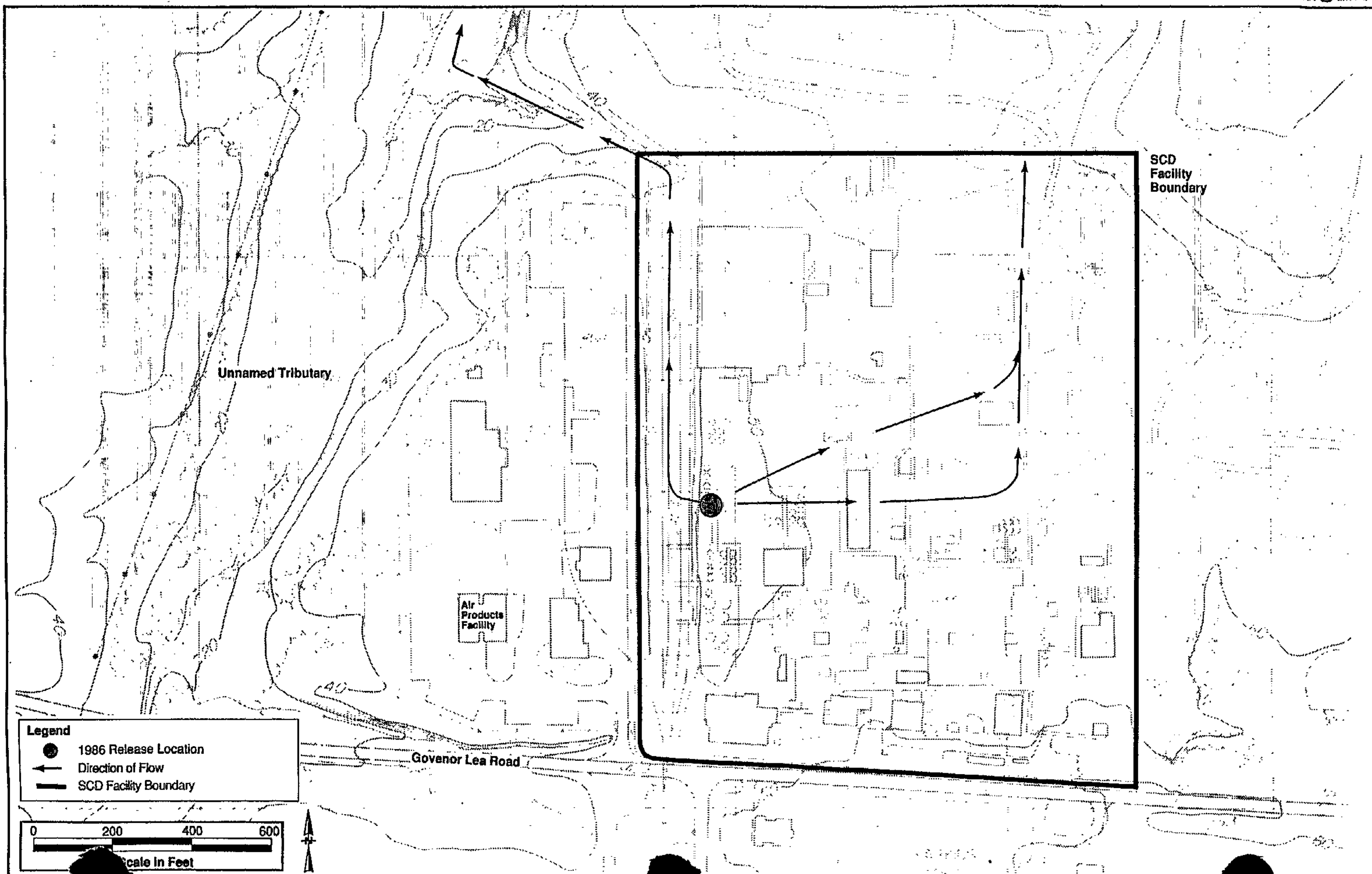

FIGURE 1-5 1986 RELEASE FLOW[illegible]WAYS
STANDARD CHLORINE OF DELAWARE, INC.

- SCD recovered a high percentage of the material and reprocessed it for further use. A containment area (the sedimentation basin) was constructed on-site for storage of recovered material.

- SCD recovered material which was still present on-site as well as material which had flowed off-site.

SCD retained Weston Services, Inc. (WSI), a wholly-owned subsidiary of WESTON, to provide emergency technical and remedial services for the remediation of this release. A complete description of the investigative and corrective actions conducted in response to the 1986 release is provided in the 22 April 1988 WESTON report, "Report on Response and Cleanup Efforts of a 5 January 1986 Chlorobenzene Release".

1.5 NATURE AND EXTENT OF CONTAMINATION

This section summarizes the RI characterization of site-specific chemicals in environmental media both on the SCD site and off-site. Consistent with the RI, the analytical results presented herein are discussed in terms of the total concentrations of SCD analytes, that is, the list of compounds analyzed by the SCD laboratory (see analyte list in Table 2-1 of the RI Report), and considered by the DNREC and the EPA to be site-related and relevant to a risk analysis.

1.5.1 Surface and Subsurface Soils

RI soil sampling and analysis was performed in five areas of potential environmental concern at the SCD site:

- The drainage pathway of the 1981 release.
- The drainage pathway of the 1986 release.
- Catch basin no. 1.
- The soil piles and adjacent runoff areas.
- Off-site effluent pipeline.

The following subsections detail both on-site and off-site surface and subsurface soil quality conditions in the investigated areas.

1.5.1.1 1981 Release Pathway

The RI soil analytical results indicate that contamination is most significant in the immediate area of the 1981 release. In this area, surface soils exhibit total concentrations of SCD analytes of 0.78 to 8901 mg/Kg, and subsurface soil samples taken from a depth of up to 27 feet below ground surface contained total concentrations of SCD analytes ranging from 3049 to 8324 mg/kg. Outside of the immediate area of release, levels of SCD analytes in the soils are two to three orders of magnitude less. This is especially evident in the off-site drainage swale paralleling Governor Lea Road where total concentrations of SCD analytes are generally less than 5 mg/kg in soils. These results indicate that the remediation activities conducted following the 1981 release were effective at removing the majority of the MCB found in soils in this portion of the 1981 release pathway.

1.5.1.2 1986 Release Pathway

In the northerly flow path of the 1986 release (located in the railroad track area), total concentrations of SCD analytes were highest in soil samples taken from the 0-6 foot below ground surface (BGS) interval, with a maximum concentration of 44,685 mg/Kg detected at this interval. Analyte concentrations in the railroad area decrease with depth, with total concentrations of SCD analytes below the 7 foot sampling interval ranging from 0.43 to 106 mg/Kg. The maximum soil sampling depth in this area of the site was 27 feet below ground surface.

For the eroded gully portion of the 1986 release pathway, total concentrations of SCD analytes were generally greatest in the 12-18 inch BGS sampling interval (ranging from 65.8 to 103,525 mg/Kg). These sample results indicate that not all of the site-specific chemicals had been removed from the eroded gully during the performance of the emergency remediation activities which followed the 1986 release.

Analytical results for soil samples taken in the eastern drainage ditch, representing the easterly pathway of the 1986 release, show that elevated levels of SCD analytes in soils are limited to the on-site portion of the drainage ditch, and to the upper 2-4 feet of soils underlying the on-site ditch.

1.5.1.3 Soil Piles and Soil Pile Runoff Areas

Elevated levels of SCD analytes were found in all three soil piles with total concentrations ranging from 24,210 to 105,246 mg/Kg. It should be noted that these piles were consolidated into two piles, and a more substantial cover placed over the piles as part of the interim remedial actions conducted at the site under the RI/FS program.

Soil samples taken downslope of the soil piles show total concentrations of SCD analytes less than 2 mg/Kg. These results indicate that little surface migration of site-specific chemicals has occurred from these soil piles.

1.5.1.4 Catch Basin No. 1

Subsurface soil samples obtained from borings drilled in the immediate vicinity of the on-site catch basin no. 1 (CB-1) show total concentrations of SCD analytes generally on the order of 1,000 to 5,000 mg/Kg. Site-specific chemicals were present in the soils to the maximum sampling depth of 32 feet BGS.

1.5.1.5 Off-Site Effluent Pipeline

Soil samples collected from borings drilled in the vicinity of the off-site effluent pipelines (portion between Route 9 and the SCD property boundary) show total concentrations of SCD analytes above 5 mg/Kg only at one drilling location (MW-16) adjacent to the pipeline.

Total concentrations of SCD analytes in soil samples collected from MW-16 range from 17.7 mg/Kg (15' to 17' sampling interval) to approximately 1922 mg/Kg (25' to 27' sampling interval).

1.5.2 Sediments

The RI sediment sampling and analysis program focused on three separate areas for characterization of sediment quality. These areas included:

- The sedimentation basin
- The unnamed tributary and surrounding wetlands
- Red Lion Creek and the surrounding wetlands

1.5.2.1 Sedimentation Basin

Three grab samples were taken of the impounded sediment in the basin and combined to create a composite sample which was then analyzed for SCD analytes. The total concentration of SCD analytes in this composite sediment sample was 43,931 mg/Kg.

1.5.2.2 Unnamed Tributary Sediments

Analytical results for sediment samples collected in the wetland area of the unnamed tributary, and south of the dike structure show total concentrations of SCD analytes generally less than 50 mg/Kg, with isolated areas showing levels between 100 and 700 mg/Kg. SCD analytes totalled 90,261 mg/Kg in one sediment sample collected in an area where discolored groundwater seepage was occurring. In the area between the soil dike and the silt fence constructed at the confluence of the tributary with Red Lion Creek, total concentrations of SCD analytes in wetland area sediments were highly variable with values ranging from less than 5 mg/Kg to 150,000 mg/Kg.

1.5.2.3 Red Lion Creek Sediments

As noted in Subsection 1.5.2.2, the highest concentrations of SCD analytes in sediments are present in the area of the confluence of the unnamed tributary and Red Lion Creek. Other than this area, sediment samples from Red Lion Creek and its surrounding wetlands generally had total concentrations of SCD analytes less than 15 mg/Kg. The furthest downstream (i.e., in Red Lion Creek) sediment samples collected in the RI/FS study area were obtained near the Route 9 bridge located approximately 1500 feet from the unnamed tributary/Red Lion Creek confluence. The maximum total concentrations of SCD analytes found in sediment samples at this location was 11.4 mg/Kg.

1.5.3 Surface Water

RI surface water sampling was performed in the sedimentation basin monitoring zone, the unnamed tributary, and Red Lion Creek. Interstitial water between the liners of the sedimentation basin showed the presence of site-specific chemicals (total concentrations of SCD analytes at approximately 79 mg/L and 74 mg/L in separate sampling efforts). These data suggest that the integrity of the upper basin liner is suspect.

Total concentrations of SCD analytes were generally higher in surface water samples collected in the unnamed tributary than in surface water samples from Red Lion Creek. Total concentrations of SCD analytes in surface water ranged between 0.04 and 1.5 mg/L in the unnamed tributary area compared to a non-detect to 0.36 mg/L range for samples collected from Red Lion Creek.

1.5.4 Groundwater Quality

Site-specific chemicals dissolved in groundwater of the Columbia Formation are confined dominantly within the area of the SCD property, and the portion of the off-site property directly north of the SCD facility. The site-specific chemicals have migrated in groundwater to the Red Lion Creek and the unnamed tributary, natural groundwater discharge points of the Columbia Formation in this area. The highest concentrations of site-specific chemicals dissolved in groundwater (total concentrations of SCD analytes in excess of 200 mg/L) extends from the area of the 1981 and 1986 releases to the groundwater recovery wells located north of the SCD facility.

In the area of the off-site effluent pipeline, groundwater quality impacts to the Columbia Formation are localized to an area adjacent to the pipeline.

Product that was released in the 1981 and 1986 spill areas, and subsequently migrated through the Columbia Formation water column as dense non-aqueous phase liquids (DNAPLs) would encounter a confining geologic unit (i.e., Merchantville Formation or Potomac clays) at the base of the Columbia Formation. Based on the current knowledge of the structural surface of the top of the confining unit, DNAPL migration on this confining unit would be in the direction of the slope of the confining unit, or toward the center of the SCD site. Sampling of the on-site wells, as part of the on-going groundwater quality monitoring program, has indicated the presence of DNAPL in samples obtained from a few site wells (TW-5, TW-28, TW-30, RW-2, and RW-5). The DNAPL is generally identified in the laboratory as a very thin layer or film at the base of the sample volume, suggesting a very limited thickness to the DNAPL in the subsurface environment at this site.

Groundwater samples obtained from the upper Potomac aquifer in the site vicinity show no detectable levels of site-specific chemicals. These water quality monitoring data suggest that the confining unit between the Columbia Formation and the upper Potomac aquifer has apparently restricted the migration of site-specific chemicals into the upper Potomac aquifer. The locations of the site groundwater monitor wells for the upper Potomac aquifer, and the Columbia Formation, are shown on Figure 1-6.

1.6 SUMMARY OF BASELINE RISK ASSESSMENT

1.6.1 Human Health Assessment

The human health risk assessment for this site evaluated five scenarios for both carcinogenic and non-carcinogenic risks associated with potential exposure to site-related chemicals. The five potential receptors, and potential exposure pathway/routes included in the baseline risk assessment, were as follows:

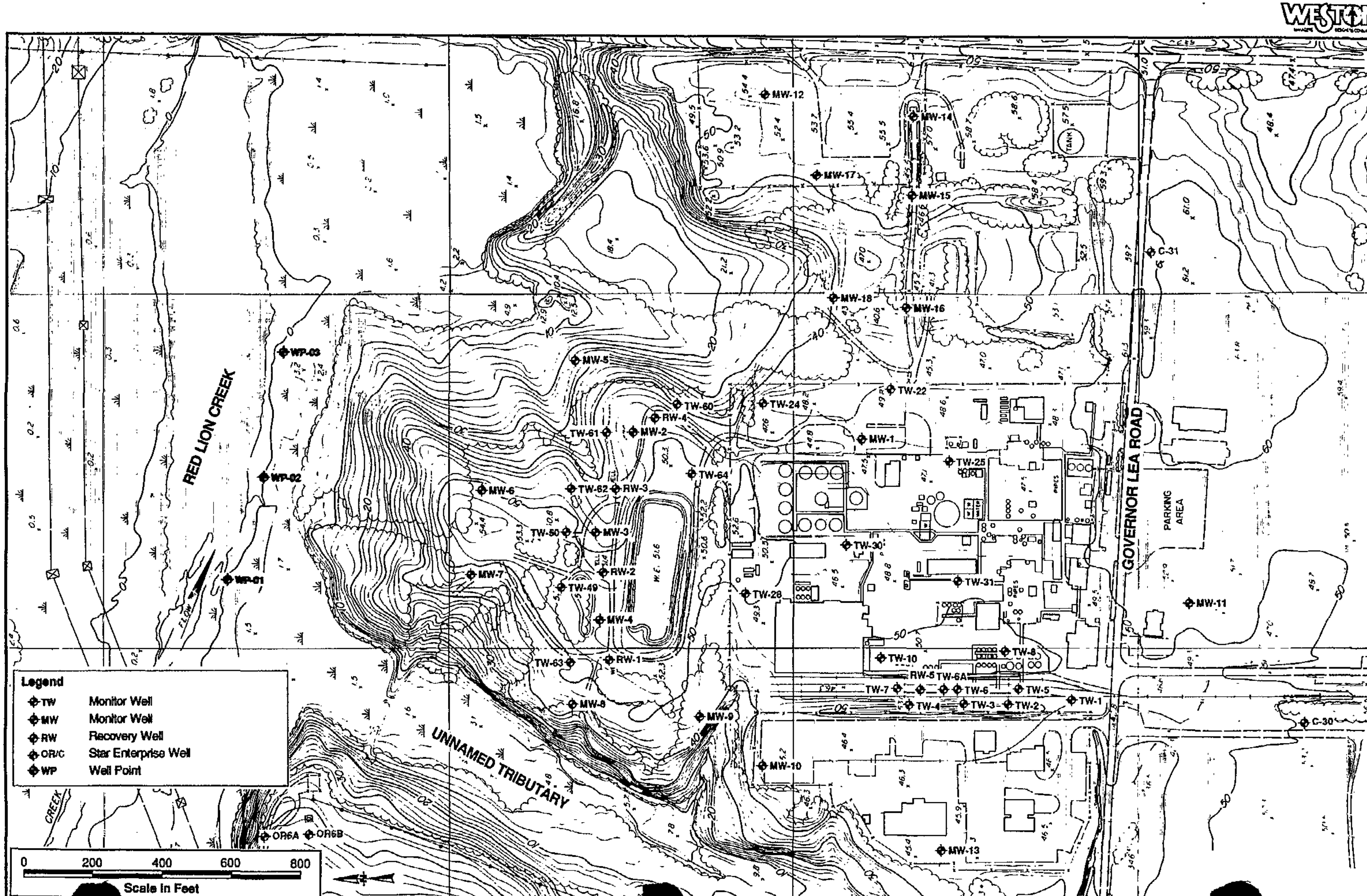

FIGURE 1-6 MONITOR WELL LO[illegible] MAP
STANDARD CHLOR[illegible] DELAWARE, INC.

- Current Worker and Current Visitor (adult only) - Potential for incidental soil ingestion, dermal adsorption from soil contact, and inhalation of airborne particulates.

- Future Worker and Future Visitor (adult only) - Potential for incidental soil ingestion, dermal adsorption from soil contact, inhalation of airborne particulates, and ingestion of groundwater.

- Current Hunter/Fisherman (adult and child) - Potential for incidental soil ingestion, dermal adsorption from soil contact, inhalation of airborne particulates, ingestion of fish, dermal adsorption from surface water contact, and dermal adsorption from sediment contact.

The results of the risk characterization (non-carcinogenic and carcinogenic risks) of the scenarios presented above are summarized as follows:

- Non-carcinogenic Risks

  - Current Worker: The total hazard indices (all compounds and all routes of exposure) exceed one (values of 3 and 5 for average and upper 95% exposure concentrations, respectively). Dermal contact accounts for over 80 percent of the total non-carcinogenic risk under this scenario.

  - Current Visitor: The total hazard indices are 0.6 and 1.1 (average and upper 95% exposure concentrations, respectively), indicating that adverse non-carcinogenic health effects under the defined exposure conditions are not likely.

  - Future Worker and Future Visitor: Exclusive of the groundwater ingestion exposure pathway, non-carcinogenic risks associated with the future worker and visitor are the same as those potential risks evaluated for the current worker and visitor (i.e. over 80 percent of risk is posed through dermal contact). Including the groundwater ingestion pathway into the risk calculation results in total hazard indices of 210 and 329 for average and upper 95% exposure concentrations respectively for the future worker scenario. Similarly, the future visitor scenario results in total hazard indices of 21.3 and 33.4 (average and upper 95% exposure concentrations respectively) when potential groundwater ingestion is added to the scenario. Including the potential exposure through the ingestion of on-site groundwater from the Columbia Formation overstates the potential future risks at the site. Ingestion of groundwater as a potential future pathway is considered highly unlikely since potable water is currently supplied to the site and a reliable source of potable groundwater is available off-site.

- Hunter/Fisherman:

  Adult: The chronic hazard indices calculated under the average and upper 95% exposure concentrations are 0.7 nd 1.3 respectively, indicating that adverse non-carcinogenic health effects under the defined exposure conditions are not likely. Dermal contact with soil and sediment is the principal contributor to the potential risk.

  Child: The chronic hazard indices for this scenario exceed one (values of 1.8 and 3.3). Principal contributors to this risk include dermal contacts and ingestion of soil.

- Carcinogenic Risks

  - Current Worker: Total carcinogenic risks for all pathways ranges from 7 in 100,000 to 1 in 10,000. As with non-carcinogenic risk, dermal contact with soils accounts for the over 80 percent of the risk.

  - Current Visitor: The total carcinogenic risk for the current visitor scenario ranges from 1 in 100,00 to 2 in 100,000. Again, dermal contact accounts for the over 80 percent of the risk.

  - Future Worker and Future Visitor: Exclusive of the groundwater ingestion exposure pathway, carcinogenic risks for future workers/visitors are the same as the current scenario for these potential receptors. Including groundwater ingestion into the future worker/visitor scenarios results in total carcinogenic risks ranging from 3 in 1000 to 5 in 1000 for the future worker, and 3 in 10,000 to 5 in 10,000 for the future visitor. For the reasons previously stated, degrees of potential health effects for these future scenarios are overstated since the potential for future groundwater use on-site is highly unlikely.

  - Hunter/Fisherman:

    Adult: Total carcinogenic risks for the adult range from 3 in 100,000 to 5 in 100,000. Dermal contact with soil and sediment account for greater than 50 percent of the potential risk.

    Child: Total carcinogenic risks ranged from 1 in 100,000 to 2 in 100,000. Dermal contact with soil and sediment account for greater than 50 percent of the potential risk.

In addition to the groundwater ingestion exposure pathway which is considered to be highly unlikely and overstates the potential risks under the future worker and visitor scenarios, the principal sources of uncertainty in the human health risk assessment are:

- Due to the sampling of soils and sediments in areas of known contamination, sampling bias results in assumed exposures that are higher than probable.

- The on-site areas (eastern drainage ditch, railroad tracks) that were sampled are not normally traversed by workers or visitors, because they are unsuitable for walking or work activity. The risk assessment assumed that these areas are constantly occupied by workers or visitors when they are at the site. This results in assumed exposure that are higher than probable.

- The off-site areas that were sampled are relatively remote, and not frequently visited by plant workers or visitors. The risk assessment has assumed that these remote areas are constantly occupied by workers or visitors when they are at the site. These areas are located on industrially-owned property which have fences or natural barriers to access. With regards to the hunter/fisherman scenario, the off-site areas that were sampled are the least likely areas of human encounter due to their unstable footing conditions (i.e., steeply sloped areas and wetlands). The aforementioned results in assumed exposures that are significantly higher than probable.

- The inhalation of vapors from chemical contamination of soils and sediments represents a pathway of potential exposure to human receptors. However, estimating potential exposure to air emissions (those from sediment and soil only) is difficult since appropriate predictive air models are not available, and small amounts of emissions generated by this active facility would compound the results of ambient air monitoring data thereby resulting in artificially elevated risk levels. Nevertheless, inhalation of volatilized chemicals from soils and sediments would necessarily increase the receptor dose and resultant risk. The extent to which vapor inhalation contributes to the carcinogenic and non-carcinogenic risks cannot be estimated at this time.

1.6.2 Ecological Risk Assessment

The assessment of potential ecological risks associated with the chemicals of concern at the SCD site are summarized as follows:

- No potential exists for adverse effects to occur to the white-tailed deer through ingestion of browse. For the meadow vole, the results indicate a potential for adverse effects to occur through vegetation ingestion.

- There is no indication of any potential for adverse effects to occur to the great blue heron through fish and surface water ingestion.

- The potential exists for minimal adverse chronic effects to occur to the aquatic life of Red Lion Creek and its tributaries due to chlorinated benzene concentrations in the surface water.

- Total chlorinated benzenes are present in sediments at concentrations that exceed the LC_{50} concentrations determined in the sediment toxicity test. Thus, there is a potential for adverse effects to occur to the epibenthic and benthic community within the sediment sampling area.

- Total chlorinated benzenes were present in the off-site soils at concentrations that exceeded the LOEL concentrations determined in the seed germination test. Thus, there is a potential for adverse effects to occur to the terrestrial vegetation within the soil sampling area.

- Total chlorinated benzenes were present in site soils at concentrations that exceeded the LOEL concentrations determined in the earthworm toxicity test. Thus, there is a potential for adverse effects to occur to the soil fauna within the soil sampling area.

The principal sources of uncertainty in the ecological risk assessment are:

- Some of the sampled off-site areas are not physically amenable to support flora. Areas such as the northwestern drainage gulley have been evaluated with respect to their affect on flora populations even though this eroded gulley is an area where flora survival is difficult.

- While there is a risk posed by the contaminants in the sediments of the Unnamed Tributary, the contaminant concentrations in this area are highly variable. Therefore, the risk to benthic communities and flora is not uniform throughout the Unnamed Tributary.

1.7 SUMMARY OF SITE CONDITIONS

Information gathered and evaluated during the RI indicates that site-specific chemicals are present in surficial soils located in the on-site railroad track area. The ballast in the railroad track area reduces the ability of the contaminant to migrate via surface runoff. Additional protection against surface contaminant runoff is provided by the sediment control barrier which were installed in this area and against other site drainageways as part of the interim site remedial measures prepared by Standard Chlorine.

As indicated by the baseline risk assessment, dermal contact with soils accounts for the majority of potential risks associated with possible exposure to site-related chemicals. Direct contact with soils in the railroad area is limited due to the presence of the railroad ballast. Additionally, human traffic in this area of the site normally avoided because of the general unsuitable condition, for walking or work activity. Similarly, contact to surface soil contamination present in the on-site eastern drainage ditch will be limited and incidental since this specific area is not normally traversed by workers or visitors.

Subsurface contamination, while present at significant levels in the immediate area of the 1981 release and in the vicinity of the catch basin soil, is not being contacted by any receptors. However, the contaminated subsurface soils in these areas, and at other site locations, represent a potential contributing source to groundwater contamination.

The RI analytical data indicates the soil and sediment quality conditions in some off-site areas, particularly the northwest drainage gully and the unnamed tributary area, have been affected by the 1986 release. The levels of site-related chemicals in sediments of the unnamed tributary area are extremely valuable, with the higher concentrations, generally found in the area between the soil dike and the silt fence, a sediment barrier installed and maintained at the mouth of the unnamed tributary. Sediment analytical data indicates that this silt fence has limited the migration of contaminants into the Red Lion Creek area.

Potential ecological risks posed by the site-specific chemicals in the northwest gully and the unnamed tributary are expected to be variable due to the nonuniformity of contaminant distribution.

Potential human exposure to site-related chemicals in the unnamed tributary and the northwest drainage gully are expected to be limited since these areas are located on industrially-owned properties which have fences or natural barriers to access. Furthermore, these areas represent unlikely areas of human encounter due to the unstable footing conditions (i.e., steeply sloped and wetlands) that exist at these locations.

The risk of exposure to contaminants in the soil piles and sedimentation basin is not expected to be significant. Previous remedial measures have reduced the potential for direct or indirect exposure to the soil piles. These piles have recently been reconsolidated, from three to two piles, and outfitted with a new cover (a temporary remedial measure approved by the DNREC). Fully covering the soil piles with a flexible membrane liner, and maintaining the integrity of the cover and the surrounding sediment control barrier, reduces the potential for direct exposure to these materials, and further reduces the ability of the contaminants to migrate due to runoff from these piles.

Site-specific chemicals are present in groundwater of the Columbia Formation beneath the site, and the off-site property directly north of the Standard Chlorine facility. Groundwater samples obtained from the Upper Potomac aquifer in the site vicinity show no detectable levels of site-specific chemicals. The site-specific chemicals in groundwater of the Columbia Formation have migrated to groundwater discharge points along the unnamed tributary and Red Lion Creek. Calculation of the flux of contaminants into surface water is presented in Section 5 of this report. While site contaminants exist in the Columbia Formation, the ingestion of groundwater as a potential future exposure pathway is considered unlikely since potable water is currently supplied to the site and a reliable source of potable groundwater is available off-site.

SECTION 2

REMEDIAL ACTION OBJECTIVES

2.1 INTRODUCTION

The remedial action alternative selected for this site must address the following statutory requirements of the Superfund Amendments and Reauthorization Act (SARA) of 1986:

- The remedy must be protective of human health and the environment.
- The remedy must attain compliance with applicable or relevant and appropriate requirements (ARARs) and federal and state environmental standards, when appropriate, unless a statutory waiver in invoked.
- The remedy must use permanent solutions and alternative treatment technologies to the maximum extent practicable.

Subsection 2.2 presents ARARs identified for the site.

2.1.1 Remedial Action Objectives

The overall objectives of the remediation process at the site are to protect human health and the environment from contaminants identified at this site. These contaminants include: chlorinated benzenes, benzene, toluene, and to a lesser extent ethylbenzene, nitrobenzene, and metachloronitrobenzene. Based upon the results of the RI investigation and consideration of identified ARARs (as described in Subsection 2.2), remedial action objectives are as follows:

- Soils/sediments
  - Prevent exposure to soils/sediments containing organic compounds in excess of the risk-based or ARAR-based action levels.
  - Prevent migration of contaminants from soils and sediments that would result in off-site groundwater contamination in excess of Safe Drinking Water Act MCLs, or surface water contamination in excess of Clean Water Act Standards.

- Prevent migration of contaminants that would result in additional soil/sediment contamination.

- Groundwater/Surface Water

    - To prevent off-site migration of contaminants in groundwater exceeding Safe Drinking Water Act Standards.

    - To prevent exposure to groundwater or surface water containing compounds in excess of risk-based or ARAR-based concentrations.

    - To prevent migration of contaminants in surface water exceeding Clean Water Act and Delaware Surface Water Quality Criteria.

    - To achieve appropriate discharge standards for treatment of extracted groundwater, if applicable.

    - To prevent the release of additional contamination from the site.

    - To implement institutional control actions that would minimize use of contaminated groundwater during the aquifer remediation.

2.2 APPLICABLE OR RELEVANT AND APPROPRIATE ENVIRONMENTAL AND PUBLIC HEALTH REQUIREMENTS

U.S. Environmental Protection Agency (EPA) policy, as reflected in the Superfund Amendments and Reauthorization Act of 1986 (SARA) and in the National Contingency Plan (NCP), provides that the development and evaluation of remedial actions under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund) must include alternative site responses able to meet applicable or relevant and appropriate federal and state environmental and public health requirements (ARARs).

ARARs are defined as follows:

- Applicable Requirements, which are those cleanup standards, standards of control, and other substantive environmental protection requirements promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

- Relevant and Appropriate Requirements, which are those cleanup standards, standards of control, and other substantive environmental protection requirements promulgated under federal or state law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at a CERCLA site.

2.2.1 Identification of ARARs

Identification of ARARs is performed on a site-specific basis. Neither CERCLA, SARA, nor the NCP provide across-the-board standards for determining whether a particular remedial action will produce an adequate cleanup at a particular site. Rather, the process recognizes that each site will have unique characteristics that must be evaluated and compared to those requirements that apply under the given circumstances. Under SARA, permits for compliance with the Resource Conservation and Recovery Act (RCRA), National Pollutant Discharge Elimination System (NPDES), and Clean Air Act (CAA) regulations for on-site remedial actions are not required. CERCLA and SARA, however, do require that the selected remedial alternative meet relevant and appropriate regulations where possible.

In accordance with the requirements of the NCP, the remedial action selected must meet all enforceable and applicable requirements unless a waiver from specific requirements has been granted. A waiver from compliance with a specific ARAR can be granted for an alternative under the following circumstances:

- The alternative is an interim measure and will become part of a total remedial action that will meet ARARs.
- Compliance with the ARAR is technically impractical from an engineering perspective.
- Compliance with the ARAR will result in a greater risk to human health and the environment than other alternatives.

- The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limitation through use of another method or approach.

- With respect to a state ARAR, the state has not consistently applied, or demonstrated the intention to consistently apply the promulgated requirement in similar circumstances at other remedial actions within the state.

- For Superfund-financed response actions only, an alternative that attains the ARAR will not provide a balance between the need for protection of human health and the environment at the site and the availability of Superfund monies to respond to other sites that may present a threat to human health and the environment.

ARARs are divided into the following three categories:

- Chemical-Specific Requirements are health- or risk-based concentration limits or ranges in various environmental media for specific hazardous substances, pollutants, or contaminants. These limits may take the form of cleanup levels or discharge levels.

- Location-Specific Requirements are restrictions on activities that are based on the characteristics of a site or its immediate environment.

- Action-Specific Requirements are controls or restrictions on particular types of activities in related areas such as hazardous waste management or wastewater treatment.

The chemical-specific, location-specific, and action-specific ARARS which have been considered for this site are summarized in Table 2-1 and are described in more detail in the following subsections.

2.2.2 Chemical-Specific ARARs

"Chemical-specific requirements set health or risk-based concentration limits or discharge limitations in various environmental media for specific hazardous substances, pollutants, or contaminants" (52 FR 32496). These requirements generally set protective cleanup levels for the chemicals of concern in the designated media or indicate a safe level of discharge.

WESTON MANAGERS DESIGNERS/CONSULTANTS

Table 2-1

Regulations Considered for the SCD Site
Standard of Chlorine Delaware, Inc.

Chemical-Specific ARARs

- Resource Conservation and Recovery Act (RCRA)
- Federal Drinking Water Standards
- Federal Ambient Air Quality Standards (Clean Air Act)
- Toxic Substance Control Act (TSCA)
- Delaware Regulations Governing Hazardous Substance Cleanup
- Delaware Water Pollution Control Regulations
- State of Delaware Water Quality Standards
- Delaware Regulations Governing the Control of Air Pollution
- Delaware River Basin Commission (DRBC) Water Quality Regulations

Location-Specific

- National Historic Preservation Act
- Endangered Species Act
- Protection of Wetlands (Executive Order 11990)
- Fish and Wildlife Coordination Act
- Department of Natural Resources and Environmental Control Wetlands Regulations
- Federal Water Pollution Control Act
- Costal Zone Management Act
- Protection of Floodplains (executive Order 11988)

Action-Specific ARARs

- Federal Discharge of Treatment System Effluent Requirements (Clean Water Act)
- Federal Excavation Requirements (RCRA)
- Federal Air Emission Standards for Process Vents (RCRA)
- Federal Surface Water Control Requirements (RCRA)
- Federal Treatment Unit Requirements (RCRA)
- RCRA Hazardous Waste Generator Requirements
- RCRA TSD Facility Requirements
- RCRA and DOT Hazardous Waste Transporter Requirements
- EPA Regulations on Discharge of Dredged or Fill Material
- Delaware Environmental Protect Act
- Delaware Regulations Governing Solid Waste
- Delaware Regulations Governing Hazardous Waste
- Delaware Regulations Governing the Control of Water Pollution
- Delaware Sediment and Stormwater Regulations
- Delaware Regulations Governing the Allocation of Water
- Delaware Regulations Governing the Use of Subaqueous Lands
- State of Delaware Regulations for Licensing Water Well Contractors, Pump Installer Contractors, Well Drillers, and Pump Installers
- State of Delaware Regulations Governing the Construction of Water Wells
- Delaware River Basin Commission Groundwater Extraction Requirements

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2.2.2.1 Resource Conservation and Recovery Act (RCRA)

RCRA requirements are applicable as a chemical specific requirement for waste or contaminated material classification to the site. Contaminated materials found at the site would be considered RCRA hazardous wastes (either listed or characteristic hazardous waste). Regulations promulgated under RCRA generally provide the basis for management of hazardous waste and establish technology-based requirements for active or proposed hazardous waste facilities. RCRA requirements include, for example, groundwater protection, closure and minimum technology requirements for hazardous waste treatment, storage and disposal (TSD) facilities.

Hazardous waste identification under RCRA is detailed in 40 CFR 261. The two basic classifications of RCRA hazardous waste are as follows:

- Listed Hazardous Wastes (defined under Subpart D of 40 CFR 261), which involve specific identification of the following regulatory listings:
    - Hazardous Waste from Nonspecific Sources (F-series wastes listed under 40 CFR 261.31).
    - Hazardous Waste from Specific Sources (K-series wastes listed under 40 CFR 261.32).
    - Commercial Chemical Products (P- and U-series wastes listed under 40 CFR 261.33).
- Characteristic Hazardous Wastes (defined under Subpart C of 40 CFR 261), which involve evaluation of the following general waste characteristics:
    - Ignitability (D001 waste).
    - Corrosivity (D002 waste).
    - Reactivity (D003 waste).
    - Toxicity (D004 to D043 wastes) that is due to specific chemical compounds.

If a waste is not a listed hazardous waste, it may still be a hazardous waste if it meets any of the four aforementioned characteristics; these characteristics can be determined by specific tests cited in the regulations. In addition, hazardous waste definitions also may apply to waste mixtures, spill cleanup residues, treatment residues "derived from" wastes, and other related situations.

Since 1966, the site has been involved in the manufacture of chlorinated benzenes, specifically chlorobenzene, p-dichlorobenzene, o-dichlorobenzene, and lesser amounts of m-dichlorobenzene and trichlorobenzene. A review of the RCRA Subpart D regulations (40 CFR 261.33) indicate that wastes resulting from the 1981 and 1986 releases may be classified as contaminated soils containing one or more of the following:

- U037 - Monochlorobenzene
- U070 - o-dichlorobenzene
- U071 - m-dichlorobenzene
- U072 - p-dichlorobenzene

Any remedial alternative involving off-site treatment or disposal must go to a RCRA-permitted TSD facility. In addition, any land disposal activities that involve placement of soils contaminated with listed or characteristic waste may be subject to the RCRA land disposal restrictions (LDRs).

2.2.2.2 Federal Drinking Water Standards

Under the Federal Safe Drinking Water Act (SDWA), EPA established regulations to protect the public from contaminants in drinking water. These SDWA regulations are considered relevant and appropriate for the site since the deep groundwater under the site is the Potomac aquifer which is an important regional water supply. The Remedial Investigation (RI) conducted at the site determined that groundwater contamination is limited to the shallow, unconfined Columbia aquifer. No potable use wells in the immediate vicinity of the site are known to draw water from this aquifer. Since there are no current receptors locally, this ARAR is based on a future use scenario. The National Interim Primary Drinking Water Standards, established under the SDWA, are promulgated as maximum concentration limits (MCLs). A MCL represents the maximum allowable level of a constituent in public water supply systems. SDWA MCLs for the site contaminants of concern are summarized in Table 2-2.

2.2.2.3 Federal Surface Water Quality Criteria

The provisions of 40 CFR 131 (Clean Water Act) state that remedial actions shall attain federal surface water quality criteria for designated water use where they are relevant and appropriate. Federal surface water quality criteria documents have been published for 65 pollutants listed as toxic under the Clean Water Act (CWA). These criteria are unenforceable guidelines that may be used by states to set surface water quality standards based on designated water use. Although these criteria were intended to represent reasonable levels of pollutant concentrations consistent with the maintenance of designated water uses, states may appropriately modify these values to reflect local conditions.

Surface water quality criteria are generally provided for different surface water use designations. Concentrations are specified that, if not exceeded, should protect most aquatic life against acute toxicity or chronic toxicity (24-hour average). For many chemical compounds, specific criteria have not been established because of insufficient data. Table 2-3 provides the most recent water quality criteria for those compounds found in surface water. Water quality criteria for the protection of aquatic life and the protection of human health (fish and water consumption) are presented. Federal water quality criteria will be compared with Delaware surface water quality standards. For the parameters where state standards have been established, the more stringent standard will be considered the ARAR. The surface water quality criteria will be an ARAR when they are considered relevant and appropriate based on designated water use.

2.2.2.4 Federal Ambient Air Quality Standards

The Clean Air Act (CAA) was enacted to maintain and enhance the quality of air resources to protect public health and welfare. Under the CAA, EPA established Primary and Secondary National Ambient Air Quality Standards (40 CFR Part 50). These primary

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Table 2-2

Federal Drinking Water Standards
Standard Chlorine of Delaware, Inc.

Organic Constituent	Primary MCL[1]
Benzene	5
Chlorobenzene	100
Chlorinated Benzenes	
1,2-Dichlorobenzene	600
1,3-Dichlorobenzene	600
1,4-Dichlorobenzene	75
Dichlorobenzenes	
Ethylbenzene	700
Hexachlorobenzene	1
Nitrobenzene	
PCBs	0.5
Pentachlorobenzene	
Toluene	1000
1,3,5-Trichlorobenzene	
1,2,4-Trichlorobenzene	70
1,2,3-Trichlorobenzene	
1,2,4,5-Tetrachlorobenzene	
1,2,3,4-Tetrachlorobenzene	

Notes:

(1) All values are in ug/l unless otherwise indicated.

Table 2-3

Surface Water Quality Criteria
Standard Chlorine of Delaware, Inc.

	Human Health Based			
Organic Constituent	Delaware Fish Ingestion Only	Delaware Fish & Water Ingestion	Federal Fish Ingestion Only	Federal Fish & Water Ingestion
Benzene	89	1.2	71	1.2
Chlorobenzene	26100	680	21000	680
1,2-Dichlorobenzene	21800	2800	17000	2700
1,3-Dichlorobenzene	4300	410	2600	400
1,4-Dichlorobenzene	24000	75[1]	2600	400
Ethylbenzene	35000	3200	29000	3100
Hexachlorobenzene	0.00088	0.00085	0.00077	0.00075
Nitrobenzene	2200	17	1900	17
Toluene	370000	10000	200000	6800
1,2,4-Trichlorobenzene	19000	680		

Notes:

All values are in ug/l unless otherwise indicated

(1) Value presented is the primary MCL as given in the State of Delaware Regulations Governing Public Drinking Water Systems as amended May 19, 1989.

standards define contaminant concentration limits in external, publicly accessible air which ensure, with an adequate margin of safety, the protection of public health. Secondary standards are air quality standards which will protect public welfare from known and anticipated adverse effects of a particular pollutant. National Ambient Air Quality Standards are listed in Table 2-4.

Inherent in these regulations is the provision that ambient air quality will be maintained without significant deterioration of existing air quality in any portion of any state. In addition, individual states are encouraged to adopt their own, often more restrictive, ambient air quality standards. These standards may be considered an ARAR for point source air emissions from a remedial technology.

2.2.2.5 Toxic Substance Control Act (15 USC 2601)

The Toxic Substance Control Act (TSCA) was enacted by the U.S. Congress (October 1976) in response to its findings that human beings and the environment were being exposed to a large variety of chemical substances and mixtures whose manufacture, processing, and distribution may present an unreasonable risk of injury to human health and the environment. The purpose of the act was to regulate commerce and protect human health and the environment by requiring testing and necessary use restrictions on certain chemical substances. TSCA set forth the following policy:

- Adequate data should be developed with respect to the effect of chemical substances and mixtures on health and the environment, and the development of such data should be the responsibility of those who manufacture and/or process such chemical substances and mixtures.

- Adequate authority should exist to regulate chemical substances and mixtures that present an unreasonable risk of injury to health or the environment, and to take action with respect to chemical substances and mixtures that are imminent hazards.

- Authority over chemical substances and mixtures should be exercised in such a manner as not to impede or create unnecessary economic barriers to technological innovation, while assuring that such innovation and commerce in such chemical substances and mixtures does not present an unreasonable

Table 2-4

National Ambient Air Quality Standards
Standard Chlorine of Delaware, Inc.

POLLUTANT	STANDARD	AVERAGING PERIOD	REGULATORY STATUS(a)
Sulfur oxides	Primary Primary Secondary	12-month arith. mean 24-hour average (b) 2-hour average (b)	80 ug/cu. m (0.03 ppm) 365 ug/cu. m (0.14 ppm) 1300 ug/cu. m (0.5 ppm)
Particulate matter	Prim. & Sec. Prim. & Sec.	Annual arith. mean 24-hour average	50 ug/cu. m 150 ug/cu. m
Carbon monoxide	Prim. & Sec. Prim. & Sec.	8-hour average 1-hour average	9 ppm (10 mg/cu. m) (c) 35 ppm (40 mg/cu. m) (c)
Nitrogen oxides	Primary Secondary	Max. daily 1-hour avg. 1-hour average	0.12 ppm (235 ug/cu. m) (d) 0.12 ppm (235 ug/cu. m) (d)
Lead	Prim. & Sec.	Quarterly mean	1.5 ug/cu. m

Notes:

(a) National short-term standards are not to be exceeded more than one in a calendar year
(b) National standards are block averages rather than moving averages.
(c) National secondary standards for carbon monoxide have been dropped.
(d) Maximum daily 1-hour average: averaged over a 2-year period, the expected number of days above the standard must be less than or equal to one.

risk of injury to health or the environment.

TSCA entrusted EPA with the authority to implement and enforce this policy.

TSCA is not considered to be an ARAR for this site since it is not relevant or appropriate to the chemical substances and their disposition on-site.

2.2.2.6 Delaware Regulations Governing the Control of Water Pollution

The Delaware Water Pollution Control Regulations were enacted to ensure that the surface and ground water of the state are maintained at a quality consistent with established criteria to ensure that the health, safety, and welfare of the citizens of the state are maintained. The regulations prohibit the discharge of any pollutant from a point source into surface or ground water, directly or indirectly, without a Delaware Department of Natural Resources and Environmental Control (DNREC) permit. Permitting requirements and industrial waste effluent limitations are presented in the regulations. Discharges subject to the requirements of the National Pollutant Discharge Elimination System (NPDES) are required to submit a NPDES application to DNREC, unless a complete Refuse Act application is on file at DNREC. NPDES requires the acquisition of a discharge permit before any process or treated wastewater can be discharged.

The SCD facility currently holds an NPDES permit for the discharge of its process wastewater. Discharges of treated groundwater or surface water resulting from remedial activities at the site to Red Lion Creek or the unnamed tributary will require separate permitting. If such discharges are conveyed to the existing SCD wastewater treatment plant, present effluent limitations or permit conditions as defined under the existing NPDES permit must not be exceeded without obtaining a new or revised permit.

The Delaware Water Pollution Control Regulations are considered to be an ARAR for this site and would be applicable to discharges through the existing wastewater treatment system and NPDES compliance point.

2.2.2.7 Delaware Water Quality Standards

DNREC has developed water quality standards to maintain state surface waters at a satisfactory quality consistent with public health and public recreation purposes, the propagation and protection of fish and aquatic life, and other beneficial uses of water. In instances where conflicts develop between stated surface water uses, stream criteria, or discharge criteria, the designated water use of the body of water will determine the required stream criteria. These stream criteria will then serve as the basis for specific discharge limits or other necessary controls.

DNREC has classified the Red Lion Creek stream basin with the following designated uses:

- Primary Contact Recreation
- Secondary Contact Recreation
- Industrial Water Supply
- Fish, Aquatic Life, and Wildlife
- Agricultural Water Supply
- Public Water Supply (future use goal - not currently attained)

Surface water quality criteria for toxic substances are provided for the protection of aquatic life and human health. Table 2-3 provides the most recent surface water quality criteria for the contaminants of concern at the site. Human health based freshwater fish and water ingestion water quality criteria, which only pertain to surface waters of the state designated as public water supply sources, are not applicable to the Red Lion Creek stream basin. The human health based fish ingestion only criteria are considered to be relevant and appropriate to this site and will be an ARAR. The aquatic life based criteria for fresh water fish are also relevant and appropriate to this site and will be considered as an ARAR.

2.2.2.8 Delaware Regulations Governing the Control of Air Pollution

The Delaware Regulations Governing the Control of Air Pollution specify emission standards which establish minimum control requirements necessary to ensure a reasonable quality of air throughout the state. DNREC has developed ambient air quality standards to facilitate the management of air resources within the state. Such ambient air quality standards are applied to all areas outside of a source property line in the evaluation of operating permits.

The regulations prohibit the construction, installation, alteration, or operation of any equipment, facility, or air contaminant control device which will emit or prevent the emission of air contaminants, without an approved DNREC permit. In addition, New Source Performance Standards (NSPS), which apply best available control technology, are presented. The State Air Pollution Control Regulations will be considered as an ARAR with respect to point source emissions from remedial technologies. DNREC air pollution control permitting may be applicable to any changes or additional streams proposed for existing permitted air discharges at the plant.

2.2.2.9 Delaware Regulations Governing Hazardous Substance Cleanup

These regulations have common elements to the National Contingency Plan and CERCLA in that these regulations establish the various procedures with which sites are identified, investigated, and remediated. Included in these regulations are the procedures for facility identification, initial investigation, facility evaluation, identification and notification of potentially responsible parties (PRPs), placement of the facility on the state priority list, negotiations with PRPs, remedial investigation, feasibility study, plan of remedial action, and remediation. The Standard Chlorine site has already undergone several of these steps within the regulation and is currently in the feasibility study step.

Included in the regulations are procedures for establishing site cleanup levels. These levels shall be based on risk to human health and the environment. Generally, cleanup levels for soil and groundwater will be the natural background levels if the background levels exceed 1.0E-05 cancer risk level or hazard index level of one. When the natural background is below these levels, then the cleanup goal will be 1.0E-05 cancer risk level or hazard index equal to one level. Alternatively for groundwater, the drinking water MCL may be used if the DNREC determines it is appropriate based on risk.

These regulations are considered an ARAR for the site.

2.2.2.10 Delaware River Basin Commission (DRBC) Water Quality Regulations

The DRBC has established surface and ground water quality standards to maintain the quality of basin waters at a safe and satisfactory condition to meet designated uses. DRBC stream quality requirements prohibit discharges which cause or permit any pollution or violate stated effluent quality requirements. The DRBC has divided the basin into separate zones, with distinct stream quality requirements for individual zones. Red Lion Creek and its tributaries are located within DRBC Zone 5, which includes tidal, interstate streams extending from the Pennsylvania-Delaware boundary line (River Mile 78.8) to Liston Point (River Mile 48.2) and tidal portions of the tributaries thereof. Stream quality and effluent discharge requirements for Zone 5 may be relevant and appropriate to remedial discharges to surface water.

DRBC has also adopted the National Interim Primary Drinking Water Standards (SDWA MCLs, see Table 2-2) as its groundwater quality objectives to prevent degradation of basin groundwater quality. In addition, the DRBC may establish requirements, conditions, or prohibitions above and beyond promulgated standards to protect the quality of basin groundwater. DRBC standards for groundwater may be relevant and appropriate and will be considered if there are requirements beyond that of the SDWA (see Section 2.2.2.2).

2.2.3 Location-Specific ARARS for the Site

Location-specific requirements "set restrictions on activities depending on the characteristics of a site or its immediate environs" (52 FR 32496). In determining the use of these location-specific ARARs for selection of remedial actions at CERCLA sites, one must investigate the jurisdictional prerequisites of each of the regulations. Basic definitions, exemptions, etc., should be analyzed on a site-specific basis to confirm the correct application of the requirements.

2.2.3.1 National Historic Preservation Act (16 USC 470 et seq.)

The National Historic Preservation Act is applicable to those properties included in, or eligible for, the National Register of Historic Places. This ARAR requires that action be taken to preserve historic properties. Planning of action to minimize the harm to national historic landmarks is required. The applicability of this ARAR will be determined by the findings of the ongoing site archaeological assessment.

2.2.3.2 Endangered Species Act (16 USC 1531 et seq.)

The Endangered Species Act of 1973 is applicable if endangered species or threatened species are present. This act requires that action be performed to conserve endangered species or threatened species. Activities must not destroy or adversely modify the critical habitat upon which endangered species or threatened species depend. As identified by the Remedial Investigation (RI), none of the endangered wildlife species for the State of Delaware have been observed or are expected within the vicinity of the SCD site.

2.2.3.3 Fish and Wildlife Coordination Act (16 USC 661 et seq.)

The purposes of the Fish and Wildlife Coordination Act are to conserve and promote conservation of fish and wildlife and their habitats. The act pertains to activities that modify a stream or river and affect fish or wildlife. Actions must be taken to protect those fish and wildlife resources affected by site activities. The requirements of this act may be relevant or appropriate with respect to remedial activities involving disturbance in the unnamed tributary or Red Lion Creek.

2.2.3.4 Protection of Wetlands (Executive Order 11990)

This regulatory requirement pertains to wetlands as defined in Section 7 of the Executive Order. Wetland areas at the SCD have been mapped in the areas of the unnamed tributary and Red Lion Creek and this mapping is presented in the RI. Activities performed in a wetland area are required to take actions to minimize the destruction, loss, or degradation of the wetland. This requirement, therefore, may be relevant and appropriate to any remedial activity impacting the areas around the unnamed tributary and Red Lion Creek, which have been classified as a wetland and it will be considered an ARAR.

2.2.3.5 Delaware Wetlands Regulations

The regulations require the acquisition of a DNREC permit before conducting any activity within a wetlands area. These activities include, but are not limited to dredging, draining, drilling, filling, bulk heading, and construction. Permits granted by the DNREC are divided into the following two categories:

- Type I Permits; required for projects which affect a total of one acre of wetlands or less, with no building of structures included.
- Type II Permits; required for projects involving more than one acre of wetlands, or which include the building of structures.

Remedial activities in the areas which have been mapped as wetlands around the unnamed tributary and Red Lion Creek may impact wetlands and therefore these regulations will be considered an ARAR.

2.2.3.6 Protection of Floodplains (Executive Order 11988)

This regulatory requirement controls construction and other development activities in areas subject to flooding and their fringe areas. It is anticipated that portions of the unnamed tributary, Red Lion Creek, and fringe areas are located within the 100-year floodplain.

Floodplain maps for this area have been requested from FEMA, however, the documents have not yet been obtained. The applicability of this ARAR will be determined following final delineation of the 100-year floodplain within the site.

2.2.4 Action-Specific ARARs for the Site

Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to site remediation. These requirements are triggered by the particular activities that are selected to accomplish the cleanup. Since there are usually several alternative actions for any remedial site, very different potential requirements can come into play. These action-specific requirements do not in themselves determine which remedial alternative is selected; rather they indicate how a selected alternative must be implemented.

2.2.4.1 Discharge of Treatment System Effluent

Regulations pertaining to the discharge from an aqueous or wastewater treatment system have been established under the Clean Water Act (CWA). The CWA requirements will be applicable or relevant and appropriate to the discharge from a groundwater treatment system or other water discharge point associated with a remedial technology. These waters may be handled together through the existing SCD treatment system and NPDES discharge permit. Under the CWA regulations, the use of best available technology (BAT) economically achievable is required to control toxic and nonconventional pollutants, and the use of best conventional pollutant control technology (BCT) is required to control conventional pollutants (40 CFR 122.44 (a)). Technology-based limitations, however, may be determined on a case-by-case basis.

To meet the requirements of 40 CFR 122.44 (i), the discharge must be monitored for the:

- Concentration and mass of each pollutant
- Volume of effluent.
- Frequency of discharge and other measurements as appropriate.

In addition, approved test methods for the waste constituents to be monitored must be followed (40 CFR 136). Detailed requirements for analytical procedures and quality control are provided and sample preservation procedures, container materials, and maximum allowable holding times are prescribed. In addition to monitoring, the treatment facility must be properly operated and maintained (40 CFR 122.41).

Best Management Practices (BMP) program requirements will be considered as relevant and appropriate for on-site remedial actions. BMP requirements are designed to prevent the release of toxic constituents to surface waters (40 CFR 125.100). The BMP program is primarily setup to establish specific procedures for the control of toxic and hazardous pollutant spills. The procedures and facility design includes a prediction of direction, rate of flow, and total quantity of toxic pollutants where experience indicates a potential for equipment failure.

2.2.4.2 Excavation

Movement of excavated RCRA materials outside of the area of contamination and placement in or on land will require consideration of land disposal restrictions (40 CFR 268) for the excavated waste or contaminated soil. Land disposal restrictions would not apply to materials moved or consolidated within the area of contamination as long as placement does not occur.

In the event that the sedimentation basin is excavated and the material removed off-site, the impoundment closure requirements under RCRA may be relevant and appropriate with respect to "clean closure" or post closure monitoring. Excavation, construction, or filling activities in wetlands, floodplain areas, or surface water bodies will involve other ARARs discussed in the following subsections. Excavation would also effect the sediment and erosion control requirements of DNREC (discussed further in Section 2.2.4.10).

2.2.4.3 Air Emission Standards for Process Vents (40 CFR 264.1030)

Air emission standards pertaining to process vents of operations, including air stripping operations, that manage hazardous waste with organic concentrations of at least 10 ppm by weight are outlined in 40 CFR 264.1030. This may be a relevant and appropriate requirement for the air stripper used for groundwater treatment. The stripper must be operated to reduce organic emissions below 1.4 kg/hr and 2800 kg/year, or reduce, by use of a control device, total organic emissions from the stripper system by 95 weight percent. The air discharge from the stripper is used as combustion air for the plant boilers. This represents a thermal destruction control device for the air stripper discharge.

2.2.4.4 Treatment

Treatment technologies may be used as part of the remedial alternatives for contaminated soils, sediment, and groundwater. Some of the contaminated materials will meet RCRA criteria for characteristic hazardous wastes (see Section 2.2.2.1). RCRA requirements would be applicable to the treatment technologies to be used for the materials meeting RCRA criteria for hazardous waste. The substantive requirements of RCRA treatment would have to be met by the remedial technologies.

RCRA Design and Operating standards for a treatment technology which will be reviewed to determine the applicable portions include:

- Land Treatment Unit (40 CFR 264.270-283) may be considered as a means to biodegrade the site contaminants in an above ground system. The main RCRA requirements which may be applicable for land treatment include run-on and run-off control, design of treatment zone, treatment demonstration, seepage collection, operating plan, monitoring and closure/post closure.

- Incineration (40 CFR 264.340-351) may be considered as a treatment technology for contaminated soils and sediments. The primary RCRA requirements which may be applicable to a high temperature incinerator include destruction and removal efficiency of at least 99.99%, waste feed analysis, trial burn, operational monitoring and control, and HCl emission limitations.

- Thermal Treatment (40 CFR 265.370) may be considered using a thermal desorption unit for treating contaminated soils and sediment. Main RCRA requirements for thermal treatment which may be applicable include: waste feed analysis, inspections and monitoring, operating requirements, and closure.

- Chemical, Physical and Biological Treatment (40 CFR 265.400-406) may be considered for stabilization of soils and sediment or biological degradation. Primary RCRA requirements for these type of facilities include waste feed analysis, trial tests, operating controls, inspections, and monitoring and closure.

- Industrial Boiler Treatment (40 CFR 266 Subpart H) regulations pertain to the burning of hazardous waste in a boiler. The vapor emissions from the air stripper at the SCD site are used in the plant boilers as combustion air. In this manner the contaminants are thermally destroyed in the boiler. The air discharged from the stripper is from the treatment of contaminated groundwater extracted from the site. SCD has indicated that the U.S. EPA has ruled that the combustion of the groundwater air stripper stream in the company's industrial boiler is not covered by the Boiler and Industrial Furnace Rule. Therefore, these RCRA requirements are not ARAR.

  The industrial boiler regulations include requirements for waste analysis; emission standards for particulate, CO, hydrocarbons, HCl, Cl_2; destruction and removal efficiency (DRE) of 99.99%; operating parameters to ensure compliance; monitoring and inspections. Certain waivers and exemptions exist for small quantity burners, low risk waste, and DRE trial burn requirements. Additional requirements pertain to handling of combustion residues and direct transfer of waste to the boiler.

2.2.4.5 Landfill and Surface Impoundment Requirements

RCRA requirements for landfill (40 CFR 264 Subpart N) and surface impoundments (40 CFR 264 Subpart K) may be relevant and appropriate to the SCD site sedimentation basin. Several options exist for ultimate disposition of the sediments in the basin and the basin itself. This is an existing lined basin containing contaminated sediments. The basin will not be operated as a surface impoundment and may be used in some manner. The contaminated materials will either be removed and treated, or the residues will be stabilized and remain in place.

RCRA closure and post closure requirements for surface impoundments will be relevant and appropriate. For "clean closure", all residues, contaminated containment system components, leachate, contaminated subsoils and waste must be removed, and properly managed. If the contaminated material is to remain in place, free liquids must be removed and the waste material stabilized/solidified. The stabilized waste must have sufficient bearing strength to support the final cover system. The final cover must meet certain design criteria to maintain long term integrity, minimize maintenance and have a permeability less than the liner system. Post closure maintenance and monitoring would have to be implemented following closure.

RCRA landfill design criteria may be relevant and appropriate in certain situations. If the sediments are removed from the basin, treated and returned to the basin, then landfill design criteria may be relevant and appropriate. Design criteria include minimum technology requirements for liner and leachate collection systems. The liner system would be designed to prevent any migration of wastes out of the landfill and into the adjacent subsoil and would consist of a top liner and a bottom composite liner. The liner material would have to be constructed of sufficient strength and possess chemical compatibility with the contained materials to maintain its integrity. A leachate collection system would be installed over the liner to remove leachate from the landfill. After the landfill is filled and completed, a final cover system would be installed. The final cover would meet minimum design criteria to maintain integrity and minimize infiltration. Closure and post closure care requirements and monitoring would apply.

2.2.4.6 Treatment, Storage, and Disposal Facility General Requirements

Treatment, storage, and disposal (TSD) facility requirements under RCRA apply to facilities which treat, dispose, or store RCRA hazardous waste for a period of 90 days or greater. Portions of the TSD general requirements (40 CFR 264) are relevant and appropriate ARARs to the SCD site for remedial actions involving TSD activities of on-site materials qualifying as RCRA hazardous wastes. General facility requirements which may be appropriate include:

- General facility standards (Subpart B) including those for waste analysis, security, inspections, and personnel training, and construction quality assurance.
- Preparedness and prevention standards (Subpart C) addressing facility design and operation, required equipment, testing and maintenance of required equipment, communication/alarm systems, and fire control.
- Contingency plan and emergency procedures (Subpart D) procedures, plans, and training designed to respond to emergency or release situations in order to minimize the impact on human health and the environment.
- Manifest system, recordkeeping, and reporting (Subpart E) to track hazardous waste handling on-site and any off-site transportation.

2.2.4.7 Transporter Requirements

As remedial actions considered for the site may include the off-site transportation of RCRA-defined hazardous waste, RCRA transporter requirements specified under 40 CFR 263 are applicable ARARs. Material meeting RCRA hazardous waste criteria would have to be transported to a RCRA-permitted TSD. The main provision identified under the regulation is compliance with the manifest system (40 CFR 262, Subpart B). Transportation requirements addressed by the U.S. Department of Transportation (DOT) are discussed under 40 CFR 107 and 171-179.

2.2.4.8 Delaware Regulations Governing Solid Waste and Delaware Regulations Governing Hazardous Waste

The State of Delaware has promulgated its own set of solid and hazardous waste regulations. Delaware Regulations Governing Solid Waste establish the basis for the management of solid wastes, and provide design requirements for sanitary and industrial landfills, dry waste disposal facilities, resource recovery facilities and transfer stations. Nonhazardous waste materials removed from the SCD site or resulting from waste treatment should consider the Delaware solid waste management and disposal design criteria as possible ARARs.

Delaware Hazardous Waste Regulations have been adopted directly from the RCRA regulations and are sufficiently similar such that detailed presentation is not warranted at this point. Nonetheless, these regulations are equally applicable to the conditions and site activities at SCD as discussed for RCRA.

2.2.4.9 Dredge and Fill Activities

Dredge and fill activities are regulated under Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. These requirements may be relevant and appropriate to removal of sediments from Red Lion Creek and the unnamed tributary. Protection of wetlands and aquatic habitats is of primary importance for these activities. Discharge and handling of the dredged material must be performed to minimize ecological and aquatic impacts.

2.2.4.10 Delaware Erosion and Sedimentation Control Law

The Delaware Erosion and Sedimentation Control Law prohibits performing land disturbance activities without submitting a sediment and stormwater management plan and obtaining a DNREC permit. Land disturbing activities include, but are not limited to, land cleaning, soil movement, and construction. This law may be relevant and appropriate depending on the extent and type of remedial activities. Soil excavation activities should consider this ARAR.

2.2.4.11 Delaware Environmental Protection Act

This act, under 7 Delaware Code Chapter 60, establishes powers and duties for DNREC. The act sets up requirements for permits for any actions that:

- May cause or contribute to discharge of air contaminants.
- May cause or contribute to discharge of pollutants to groundwater or surface water.

- May cause or contribute to withdrawal of groundwater or surface water.
- May cause or contribute to collection, transportation, storage, processing, or disposal of solid waste.
- Involve construction, maintenance, or operation of a pipeline system.
- Involve construction of any water facility.

The act gives authority for regulations to be written for the permitting requirements for each of these actions. This act is considered ARAR for the site.

2.2.4.12 Delaware Sediment and Stormwater Regulations

Under these regulations, no activities that disturb land can be performed (unless exempted by these regulations) without an approved sediment and stormwater management plan. This plan must be consistent with these regulations, the Delaware Erosion and Sedimentation Control Law, and any adopted county or municipal ordinances. This plan must be approved before any building or grading permits are issued. The regulations outline the requirements for the management plans. These regulations do not apply if the site land development activities are regulated under other state or federal laws which provide for managing sediment control and stormwater runoff (e.g., NPDES permit for stormwater runoff). SCD has submitted an application for a permit governing stormwater discharge.

2.2.4.13 Delaware Regulations Governing the Use of Subaqueous Lands

Owners of private subaqueous lands (submerged lands and tidelands) must obtain a permit or letter of authorization from DNREC pursuant to this regulation before undertaking any activity on such lands which may contribute to the pollution of public waters, have an adverse impact on aquatic habitats, infringe upon the rights of other private owners or public use of the waterway, or make connection with other subaqueous lands. Such activities include:

- Dredging, filling, excavating, or extracting of materials.
- Construction of a shoreline erosion control structure or measure.
- Excavation of land which connects to subaqueous lands.
- Dredging of existing channels, ditches, lagoons, and other navigable waterways.
- Excavation, creation, or alteration of any channel, lagoon, pond, basin, or other navigable waterway which will connect to public subaqueous lands.

These regulations are considered ARAR for the SCD site.

2.2.4.14 Delaware Regulations for Licensing Water Well Contractors, Pump Installer Contractors, Well Drillers, Well Drivers, and Pump Installers

These regulations require that all contractors engaged in drilling, boring, coring, driving, digging, construction, installation, removal, or repair of water wells and water test wells or the installation or removal of pumping equipment in and for a water well. Licenses are to be granted by the state Water Well Licensing Board and are to be granted to individuals of the contractor. These regulations are considered ARAR for the SCD site.

2.2.4.15 Delaware Regulations Governing the Construction of Water Wells

These regulations give standards for well construction, disinfection, maintenance, and abandonment. Special construction standards are also given for monitor wells and recharge wells.

Well Construction Permits issued by DNREC are required for any new well to be installed or any change in dimensions to an existing well. No permit is required for repair to a well where location and dimensions are not changed. Any permit application for a well with a pumping capacity greater than 50,000 gpd must be advertised for public comment before a permit can be issued. Although permits are not required under CERCLA, other components of this regulation may be ARAR.

2.2.4.16 Delaware Regulations Governing the Allocation of Water

These regulations require that a water allocation permit must be obtained prior to withdrawal if a total of 50,000 gpd or more will be extracted from all sources at a particular site. Withdrawals from groundwater shall be limited to rates that will not cause:

- Long-term progressive lowering of water levels, except in compliance with DNREC management water levels.
- Significant interference with the withdrawals of other permit holders unless compensation is provided.
- Violation of water quality criteria for water supplies.
- Significant permanent damage to aquifer storage and recharge capacity.
- Substantial impact on the flow of perennial streams.

Compliance with these regulations does not exempt those who make withdrawals from the Delaware River Basin from any DRBC requirements on water extraction (i.e., approval from DRBC for extraction of more than 100,000 gpd).

2.2.4.17 Delaware River Basin Commission Groundwater Extraction Requirements

The DRBC has established measures to protect groundwater resources in order to "assure the effective management of water withdrawals to avoid depletion of natural stream flows and groundwater and to protect the quality of such water." DRBC has designated groundwater protection areas within the basin. Withdrawal or expansion of a current withdrawal from a groundwater protection area (such as extension of the groundwater extraction wells or construction of an interceptor trench) should consider the DRBC Groundwater Extraction Requirements as relevant and appropriate.

2.2.5 To-Be-Considered (TBC) Criteria for the Site

In addition to legally binding laws and regulations, federal and state environmental and public health programs issue nonpromulgated, unenforceable advisories or guidance that are not legally binding. These to-be-considered criteria or TBCs, should be evaluated along with ARARs. TBCs can include health advisories, reference doses and potency factors, proposed rules, guidance materials, or policy documents. When evaluating TBCs, professional judgement is required based upon the latest available information. The TBCs considered for the site include:

- Federal Drinking Water Standards
- Federal Surface Water Quality Criteria
- Delaware Freshwater Wetlands Regulations

2.2.5.1 Delaware Freshwater Wetlands Regulations

DNREC has proposed Freshwater Wetlands Regulations for the management and preservation of freshwater wetland areas of the state. The regulations provide for the classification of freshwater wetlands into one of four categories based upon their environmental and ecological significance. Parts of Red Lion Creek is a freshwater wetlands system and will ultimately be placed into one of the subcategories and be subject to the requirements associated with its classification.

2.3 DETERMINATION OF RESPONSE LEVELS

Response levels, as used throughout this report, represent a contaminant concentration above which remedial action may be required. Response levels have been developed by evaluating available sources of information including regulations, guidance documents, and record of decisions (RODs), and the baseline risk assessment.

The chemical-specific ARARs presented in Subsection 2.2 provide the starting point for the determination of response levels. For those media, specifically groundwater and surface water, where applicable or relevant and appropriate standards have been identified, the most stringent standard has been applied as the response level. The response levels designated based on ARARs for groundwater and surface water are presented in Table 2-5.

In the absence of chemical-specific ARARs, TBC standards can be consulted. No TBC standards were identified for the soils and sediments at the site. Relevant guidance documents and RODs were also consulted to determine response levels. Again, no applicable standards were identified. Therefore, response levels were determined based on the results of the site baseline risk assessment.

2.3.1 Derivation of Risk-Based Response Levels

2.3.1.1 General Approach

Risk-based response levels were derived for the contaminants of concern in soil and sediments based on the most reasonable maximally exposure (human or ecological) for each media. Basing the response levels on the maximally exposed receptor ensures that the levels are protective of human health and the environment. The exposure scenarios (e.g., future worker, future visitor, etc.), exposure pathways, and exposure doses were previously derived in the baseline risk assessment.

The maximally exposed or most sensitive receptor was selected for each medium on the assumption that future use of the site would be restricted to commercial/industrial use (i.e., residential development of the property would not occur). For on-site surface soils, a future worker was evaluated because this receptor has the highest expected exposure dose to on-site soils. The future worker who is exposed to on-site surface soils through ingestion, dermal contact, and inhalation of airborne soils. The exposure due to groundwater is ignored when calculating the response level for soils. Off-site soils were evaluated using flora because this receptor proved to be most sensitive to site contaminants during sediment toxicity testing. The sediment toxicity testing of soil flora was performed by evaluating lettuce seed germination in the presence of site contaminants. The results of this testing

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TABLE 2-5

Summary of ARARs-Based Response Levels
Standard Chlorine of Delaware, Inc.

	Groundwater	Surface Water		
Compound	**Federal MCL (mg/L)**	**Federal SWQC (1) (mg/L)**	**DNREC SWQC (1) (mg/L)**	**Comment**
Chlorobenzene	0.1	21.	26.1	Fed. Used
1,3-Dichlorobenzene	0.6	2.6	4.3	Fed. Used
1,2-Dichlorobenzene	0.6	17.	21.8	Fed. Used
1,4-Dichlorobenzene	0.075	2.6	24.	Fed. Used
1,3,5-Trichlorobenzene	NE	NE	NE	
1,2,4-Trichlorobenzene	0.07	NP	19.	DNREC Used
1,2,3-Trichlorobenzene	NP	NP	NP	
1,2,4,5-Tetrachlorobenzene	NP	NP	NP	
1,2,3,4-Tetrachlorobenzene	NP	NP	NP	
Pentachlorobenzene	NP	NP	NP	
Hexachlorobenzene	0.001	0.77 (2)	0.88 (2)	Fed. Used
Nitrobenzene	NP	1.9	2.2	Fed. Used
Metachloronitrobenzene	NP	NE	NE	
Benzene	0.005	0.071	0.089	Fed. Used
Ethylbenzene	0.7	NE	NE	
Toluene	1.	NE	NE	

NOTES:

NP - No standard promulgated.

NE - Not evaluated; compound not detected in media.

1) Protection of human health; fish ingestion criteria used.

2) Criteria presented in ng/L.

would also be applicable to off-site surface soils due to the flora present. The sediments were also evaluated using soil flora as the receptor.

2.3.1.2 Calculation of Risk-Based Response Levels

Risk-based response levels were derived for the human receptors (i.e. future worker) based on a hazard index of 1, and carcinogenic risk of 1.00E-05 (i.e., 1 in 100,000 excess cancer risk). A carcinogenic risk of 1.00E-05 is consistent with Delaware Regulations Governing Hazardous Substance Cleanup. It is also consistent with federal regulations; EPA's point of departure is 1.00E-06, with an acceptable range of 1.00E-04 to 1.00E-06 depending on site conditions. The response level for on-site surface soils (based on the future worker as the receptor) was calculated for total SCD analytes and 1,4-dichlorobenzene (the most significant risk contributor) using the following equations:

<u>Response Level Based on Non-carcinogenic Risk:</u>

$$RL_{HI}=\frac{C_{Actual}}{HI}*HI_{Goal}$$

Where:

RL_{HI}	=	Response level based on the hazard quotient (non carcinogenic risk).
C_{Actual}	=	Actual total average concentration of contaminants in on-site surface soils. This value equals 4,452 mg/kg (based on data presented in Table 6-2 of the RI Report). For 1,4-dichlorobenzene, this value equals 3,053 mg/kg.
HI	=	Calculated total hazard index as calculated in the baseline risk assessment. This value equals 3.2 (see Table 6-36 of the RI Report). For 1,4-dichlorobenzene, this value equals $8.81x10^{-2}$.
HI_{Goal}	=	Hazard index goal. This value is equal to 1.

Response Level Based on Carcinogenic Risk:

$$RL_C = \frac{C_{Actual}}{Risk_C} * Risk_{Goal}$$

Where:

RL_C	=	Response level based on carcinogenic risk.
C_{Actual}	=	Actual total average concentration of contaminants in on-site surface soils. This value equals 4,452 mg/kg (based on data presented in Table 6-2 of the RI Report). For 1,4-dichlorobenzene, this value equals 3,053 mg/kg.
$Risk_C$	=	Calculated total carcinogenic risk as calculated in the baseline risk assessment. This value equals 7.13×10^{-5} (see Table 6-38 of the RI Report). For 1,4-dichlorobenzene, this value equals 6.80×10^{-5}.
$Risk_{Goal}$	=	Risk goal. This value is equal to 1×10^{-5}.

Based on these equations, the response levels for on-site surface soils was calculated to be 1,391 and 625 mg/kg total average SCD target analytes for non-carcinogenic-based and carcinogenic-based response levels, respectively. Similarly, the response levels for 1,4-dichlorobenzene are an average of 34,670 and 450 mg/kg for non-carcinogenic-based and carcinogenic-based response levels, respectively. Therefore, the response level for on-site surface soils is 625 mg/kg (total SCD target analytes) and 450 mg/kg (average 1,4-dichlorobenzene), the more stringent of the calculated levels. Hereafter in this report, these response levels are referred to by only the total SCD target analyte value (i.e., 625 mg/kg).

No calculations are required for determination of response levels based on ecological risk. These risk-based response levels for off-site surface soils and sediments were derived for ecological receptors based on the LOEL. The LOEL for soil flora was determined to be 33 mg/kg, and is therefore applied as the most stringent response level. This response level is applied to off-site surface soils, and sediments.

SECTION 3

IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

The objective of this section is to identify and screen potential remedial technologies so that those technologies retained can be combined into remedial alternatives. The technology identification and screening process presented includes the results of four general steps:

1. Development of general response actions to meet remedial action objectives. Remedial action objectives were previously presented in Subsection 2.1.

2. Identification of technologies applicable to each general response action to identify those technologies that are not technically feasible for the site. These technolgies that technically feasible are further screened based on implementability, effectiveness, and cost.

3. Identification and evaluation of technology process options to select a representative process option for each technology type.

4. Identification of volumes or areas to which the general response actions might be applied, while considering the requirements for protectiveness (as identified in the remedial action objectives) and the chemical and physical characteristics of the site.

General response actions developed to address remedial action objectives are presented in Subsection 3.1. Potentially applicable technologies are identified in Subsection 3.2 and screened for technical feasibility. In Subsection 3.3, the technically feasible remedial technologies and process options are evaluated for implementability, effectiveness, and relative cost. A summary of technologies and selection of the representative process options are presented in Subsection 3.4. Subsection 3.5 presents an estimate of the areas and/or volumes of material that may require remedial action.

Throughout this document, the terms "technology types", and "process options" will appear frequently. The term "technology types" refers to broad categories of technologies, such as chemical treatment, thermal treatment, or removal. The term "process options" refers to specific processes within each technology type. For example, rotary-kiln incinerator and thermal desorption are both process options of the thermal treatment technology type.

3.1 GENERAL RESPONSE ACTIONS

General response actions describe remedial actions that may satisfy the remedial action objectives. For each general response action, more than one remedial technology may be applicable. The general response actions for each media of concern are as follows:

Groundwater and Surface Water:

- No action.
- Limited action.
- Collection/containment.
- Treatment.
- Discharge.
- Treatment using innovative technologies.

Soils and Sediments

- No action.
- Limited action.
- Collection.
- Containment.
- Treatment.
- In situ treatment.
- Disposal.
- Storage.
- Treatment using innovative technologies.

3.2 IDENTIFICATION AND SCREENING OF POTENTIALLY APPLICABLE TECHNOLOGIES

The purpose of this subsection is to identify a range of existing technology types and process options. In this subsection, a wide range of technology types and process options are identified and then screened for technical feasibility. Technologies were identified from a variety of sources including: reference documents published by the EPA, standard engineering texts, and professional experience. Technical feasibility was determined by consideration of the contaminant types and concentrations, and other site information as determined during the RI.

For each general response action, one or more technology types (and associated process options) were identified. The results of the identification and screening of the potentially applicable technologies, based on technical feasibility, are presented on Tables 3-1 and 3-2.

3.3 EVALUATION OF POTENTIAL REMEDIAL TECHNOLOGIES

In this subsection, those technologies that have been identified as being technically feasible, as noted on Tables 3-1 and 3-2, are evaluated in further detail. The screening criteria utilized consisted of:

- Implementability - The technical and administrative feasibility of implementing the technology. These are considerations such as the ability to obtain necessary permits, the availability of treatment, storage, and disposal services, and the availability of necessary equipment and skilled workers to implement the technology.

- Effectiveness - The ability of the technology to meet defined remedial action objectives. This would include the reliability of the technology with respect to contaminants and conditions present. This would include a discussion of whether the technology is conventional (proven), innovative, or emerging. Potential impacts to human health and the environment are also discussed.

- Cost - A relative estimate of the cost of implementing the technology. This is based on engineering judgement and available reference sources. Cost are given as low, moderate, or high relative to other process options within the same technology type.

After screening the technologies and process options, they were classified into one of two general categories:

- Not retained - Not expected to be applicable to achieve remedial action objectives.

- Retained - Potentially applicable and retained for further analysis.

TABLE 3-1

Identification and Screen of Groundwater and Surface Water Technolgies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Description	Recommendation
No Action	N/A	N/A	No further action taken	Technically feasible as required by the NCP
Limited Action	Institutional actions	Deed restrictions	Limit future site uses; restrictions on wells in Columbia aquifer in affected areas; restrict usage of Red Lion Creek and tributary (fishing, swimming, etc.) in affected areas.	Technically feasible
	Monitoring	Groundwater monitoring	Continued monitoring at existing/new locations	Technically feasible
		Surface water monitoring	Continued monitoring	Technically feasible
Groundwater collection/containment	Pumping	Extraction wells	Extraction of groundwater through using of groundwater wells; can be used to set up hydraulic barrier to prevent groundwater migration; ususally used in conjunction with a treatment technology	Technically feasible
		Product recovery	Low volume extraction wells for recovery of dense non-aqueous product	Technically feasible
	Vertical barriers	Slurry walls	Trenching adjacent to areas of concern and filling with soil/cement/bentonite slurry to form physical barrier against groundwater migration	Technically feasible for certain areas of site, depending on depth to Merchantville/Potomac clays.
		Interceptor trenches	Trenching adjacent to areas of concern and inserting a horizontal, perforated pipe, and backfilling with low and high permeability materials to collect groundwater	Technically feasible for certain areas of site, depending on depth to Merchantville/Potomac clays.

TABLE 3-1 (cont'd)

Identification and Screen of Groundwater and Surface Water Technolgies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Description	Recommendation
Surface water collection/containment	Diversion	Grading	Control of surface water drainage pathways by modifying existing grade	Technically feasible
		Dikes/berms/swales	Control of surface water drainage by creating distinct runoff pathways	Technically feasible
	Collection	Surface sumps/pumps	Collection and transport (to treatment unit) of surface water diverted using a diversion technology	Technically feasible
		Sedimentation basins/ponds	Generally large scale collection units for diverted surface water	Technically feasible
Treatment	Biological treatment	Aerobic/Anaerobic	Degradation/detoxification of organics using microorganisms in an aerobic/anaerobic environment (e.g. fixed film bioreactor)	Technically feasible
	Chemical/physical	~~Precipitation~~	~~Chemical alternation of the solubility of compounds in water to precipate these compounds out of solution~~	~~Not feasible for removal of most organics.~~
		Air/steam stripping	Mixing water with air in a packed column to promote transfer of the organics from the water stream to the air stream	Technically feasible
		Carbon adsorbtion	Use of carbon to adsorb the organics from the water into the carbon matrix, regeneration of the carbon removes the organics from the carbon matrix	Technically feasible
		~~Reverse osmosis~~	~~Use of high pressure to force the water through a filter, leaving the organics behind~~	~~Not technically feasible; typically used for treatment of inorganics dissolved solids~~
		~~Ion exchange~~	~~Water is passed through a resin where the ions are exchanged, removing the compounds from the water~~	~~Not feasible for removal of organics~~
		Advanced oxidation	Use of UV/H2O2 or UV/O3 to break down organics	Technically feasible

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TABLE 3-1 (cont'd)

Identification and Screen of Groundwater and Surface Water Technolgies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Description	Recommendation
	Off-site treatment	~~POTW~~	~~Discharge of untreated water to a POTW for treatment~~	~~Not technically feasible; no local POTW~~
		RCRA facility	Discharge of untreated water to a permitted RCRA facility for treatment	Technically feasible
	In-situ treatment	Bioreclamation	Array of injection and extraction wells intoduce microorganisms and nutrients to degrade organics in groundwater	Technically feasible
		~~Aeration~~	~~Injection of air into groundwater to promote air stripping of organics~~	~~Not technically feasible; technology has shown only minimal effectiveness~~
		~~Permeable treatment beds~~	~~Downgradient trenches backfilled with activated carbon to adsorb organics as groundwater passed through the carbon~~	~~Not feasible; unable to regenerate or replace carbon while in situ~~
		Chemical reaction	Similar to bioreclamation except an oxidizer is injected to promote breakdown of the organics	Technically feasible
Discharge	Onsite discharge	Local stream	Discharge of treated water to a local stream	Technically feasible
		GW injection	Injection of treated water back into the ground	Technically feasible
		IWTP	Discharge of partially or untreated water to IWTP	Technically feasible
	~~Offsite discharge~~	~~POTW~~	~~Discharge of treated waters to local POTW~~	~~Not technically feasible; no local POTW~~
Treatment using innovative technologies	Chemical/physical treatment	Evaporation/thermal stripping	Evaporation via vapor recompression; potentially resulting in two condensate; potentially used as a "roughing" technology	Technically feasible
		Adsorbtion using synthetics	Similiar to carbon adsorbtion except synthetics replace carbon as the absorber; absorber can be tailored to classes of organics	Technically feasible

TABLE 3-2

Identification and Screen of Soil and Sediment Technolgies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Description	Recommendation
No Action	N/A	N/A	No further action taken	Applicable as required by the NCP
Limited Action	Institutional actions	Deed restrictions	Limit future site uses	Technically feasible
	Security	Fencing	Limit access to affected areas	Technically feasible
	Monitoring	Wetlands monitoring	Periodic monitoring in adjacent wetlands areas	Technically feasible
Collection	Removal	Excavation	Excavation and staging soil; to be used in conjunction with a treatment, storage, and/or disposal technology	Technically feasible
		Dredging	Dredging and staging soil; to be used in conjunction with a treatment, storage, and/or disposal technology	Technically feasible
Containment	Cap	Soil covers	Basic soil covers over areas of concern	Technically feasible in non-wetland areas
		Low permeability soil caps	Clay cap over areas of concern	Technically feasible in non-wetland areas
		Synthethic membrane liners	Synthethic membrane liners, possibly composited with clay, over areas of concern	Technically feasible in non-wetland areas
		Aphalt/concrete caps	Asphalt or concrete installed over areas of concern	Technically feasible in non-wetland areas
	Sediment barriers	Geofabric	Geofabric placed over sediments to prevent movement of sediments due to erosion	Technically feasible
		Aggregate materials	Aggregate materials placed over sediments to prevent movement of sediments due to erosion	Technically feasible
Treatment	Thermal treatment	Incineration	High temperature thermal destruction of organics in affected soils and sediments	Technically feasible
		Thermal desorption	Low temperature thermal treatment and recovery of organics in affected soils and sediments	Technically feasible

TABLE 3-2 (cont'd)

Identification and Screen of Soil and Sediment Technolgies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Description	Recommendation
	Chemical treatment	Dechlorination	Chemical dechlorination of chlorobenzenes; generally using an alkoxide and polyethlylene glycol	Technically feasible for soils, not feasible to sediments or previously dredged materials with high moisture content
	Physical treatment	Stabilization/solidification	Method of binding organics mechanically to a solidified matrix, or chemically to a soil matrix	Technically feasible to non-wetland areas
		Solvent rinsing/soil washing	Excavation of soils followed by removal of organics by washing soil with water or solvents	Technically feasible
	Biological treatment	Solid phase	Degradation/detoxification of organics in the soils by microbial action	Technically feasible
		Slurry phase	Addition of water to create a slurry followed by degradation/detoxification of organics in the slurry by microbial action	Technically feasible
	Off-site treatment	RCRA TSD	Transport untreated materials to a permitted RCRA TSD for treatment and/or disposal	Technically feasible
In-situ treatment	Thermal treatment	In-situ vitrification	High temperature vitrification of soils and sediments; binding the organics in the post-treatment vitrified matrix	Technically feasible for soils in non-process areas, not feasible to sediments or previously dredged materials with high moisture content
	Biological treatment	In-situ biodegradation	Degradation/detoxification of organics in the in situ soils by microbial action	Technically feasible
	Physical treatment	Soil flushing	Extraction of organics from soils and sediments by washing with water	Technically feasible for soils, not feasible to sediments or previously dredged materials that are already water saturated
		In-situ steam injection/vapor extraction	Injection of stream and extraction of organic-laden vapor using soil vapor extraction	Technically feasible for soils, not feasible to sediments or previously dredged materials that are already water saturated

TABLE 3-2 (cont'd)

Identification and Screen of Soil and Sediment Technolgies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Description	Recommendation
Disposal	On-site landfill	Secure (RCRA) landfill	Long term disposal for soil and sediments	Technically feasible
	Off-site landfill	Secure (RCRA) landfill	Long term disposal for soil and sediments	Technically feasible
Storage	~~Storage~~	~~Permitted storage pad~~	~~Storage pad for long-term storage of containerized soils and sediments~~	~~Not Technically feasible for expected quantities~~
		~~Permitted storage building~~	~~Storage building for long-term storage of containerized soils and sediments~~	~~Not Technically feasible for expected quantities~~
Treatment using innovation technologies	Chemical treatment	Nascent state hydrodechlorination	Technology shown in lab-scale experimentation to dechlorinate DDT to DDE	Technically feasible
		Advanced oxidation	Use of UV/H2O2 or UV/O3 to break down organics	Technically feasible
	Thermal treatment	~~UV destuction~~	~~Concentrated solar energy used to supply heat to destroy organics~~	~~Not technically feasible due to meteorological conditions at the site~~
		X-TRAX	Low temperature thermal desorbtion of organics from soils	Technically feasible
	Biological treatment	Reductive dechlorination	Dechlorination of organics by anaerobic microbial action	Technically feasible
		Plant Uptake	Selected plants used to absorb contaminants	Technically Feasible

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The following subsections discuss the results of the screening of potential remedial technologies based on implementability, effectiveness and cost.

3.3.1 Groundwater and Surface Water Technologies

3.3.1.1 No Action

Description - Under no action, no remedial actions would be performed. Current remedial activities, such as the existing groundwater extraction and treatment system, would cease operation.

Effectiveness - This option is unlikely to meet the remedial action objectives. No significant reduction in toxicity, mobility, or volume (TMV) could be expected by employing this option.

Implementability - This option would require no effort to implement, because there would be no action taken and no commitment of resources.

Costs - No cost would be incurred.

Recommendation - This option will be retained for further consideration as required by the National Contingency Plan (NCP).

3.3.1.2 Institutional Actions

3.3.1.2.1 Deed Restrictions

Description - Deed restrictions are institutional controls that limit the permissible future uses of the property, and alert prospective property buyers to the presence of hazardous substances at the site. Deed restriction would likely preclude the use of the land for future residential or recreational development, and restrict installation of drinking water wells onsite.

Effectiveness - Establishing deed restrictions will limit access to the contaminated property which in turn will reduce contact with and exposure to the contaminants. This option, however, will not provide for the reduction of toxicity, mobility, or volume of the contaminants at the site, as it involves no remedial activities. The ultimate effectiveness of this technology relies upon continued future enforcement of these restrictions.

Implementability - The deed restriction option could be easily implemented. These administrative and legal procedures are widely implemented at hazardous waste sites.

Cost - The costs of this option would be low.

Recommendation - This option will be retained for further consideration.

3.3.1.3 Monitoring

3.3.1.3.1 Groundwater Monitoring

Description - Groundwater monitoring involves the periodic sampling and analysis of groundwater to evaluate contaminant levels. This provides advanced warning to decision-makers of possible changing site conditions.

Effectiveness - The monitoring of groundwater can provide advanced notice of possible increasing contamination levels unexpected or migration of contamination. This allows decision-makers to reevaluate remedial strategies. Groundwater monitoring does not provide for reduction of toxicity, mobility, or volume. In conjunction with remedial technologies, monitoring can provide useful documentation and proof of remedial progress.

Implementability - Implementation of this option would require use of monitoring wells to provide access to the groundwater. It is possible that previously drilled wells, existing from the remedial investigation phase, may be utilized for groundwater sampling. This option can be easily implemented using conventional techniques..

Cost - The costs for this option will be low.

Recommendation - This option will be retained for further consideration.

3.3.1.3.2 Surface Water Monitoring

Description - Similar to groundwater monitoring, surface water monitoring would involve periodic sampling and analysis of surrounding surface waters to monitor contaminant levels and obtain advanced warning of possible changes in site conditions.

Effectiveness - Surface water monitoring would be an effective option for evaluating possible changes in contaminant levels and site conditions. This provides decision-makers with the information necessary to evaluate remedial strategy.

Implementability - This option can be readily implemented using conventional sampling and analytical techniques. Surface water sampling and analysis has been previously implemented at the site.

Cost - The costs for this option will be low.

Recommendation - This option will be retained for further consideration.

3.3.1.4 Groundwater Pumping

3.3.1.4.1 Extraction Wells

Description - This option involves the strategic placement of extraction wells which, when in operation, are used to collect and contain the contaminated groundwater. Once the contaminated groundwater is removed from the aquifer, it can be treated by several methods as described below in Section 5.0. This is a widely-used technology, and is already in use at the site.

Effectiveness - Extraction wells reduce the volume of contaminated groundwater, and provide for reduced mobility, because they can be configured to prevent further migration of contaminated groundwater. They also provide a mechanism by which the groundwater can be transported to a remedial treatment system where toxicity is reduced. DNAPLs may not be significantly effected by the use of extraction wells. DNAPLs are insoluble in water, and may remain in the aquifer after the groundwater has been extracted.

Implementability - Use of extraction wells is a conventional technology, and is currently in use at the site. However, difficulties have been encountered with the system existing at the site in maintaining an effective hydraulic barrier to groundwater contaminant migration. System modification, including the installation of additional recovery wells, may be needed to provide increased capture of groundwater contaminants at the site.

Costs - The costs for this option could range from low to moderate.

3.3.1.4.2 Product Recovery Wells

Description - Product recovery wells are similar to extraction wells, but they are specifically designed and constructed to remove, to the extent practical, DNAPLs from the groundwater system. These wells are typically low yielding that are situated within the region of the DNAPL.

Effectiveness - Occasionally used in conjunction with extraction wells, DNAPL recovery may be able to remove a portion of the DNAPLs within a close proximity to the extraction wells. DNAPLs are very difficult to recover, because they reside within the low topographic areas on top of the confining unit. Because the movement of DNAPLs is gravity controlled, the success of DNAPL recovery wells is largely dependant on the contouring of the confining unit.

Implementability - Implementability considerations discussed for groundwater extraction wells would also apply to DNAPL recovery wells. The implementation difficulties for this option are driven by determining the number and placement of the recovery wells.

Costs - The costs of this technology is expected to be low to moderate.

Recommendation - This option will be retained for further consideration.

3.3.1.5 Vertical Barriers

3.3.1.5.1 Slurry Walls

Description - This option involves the construction of impermeable vertical walls to prevent the migration of contaminated groundwater in a particular location, or to divert the groundwater towards an extraction point. During construction of shallow slurry walls (i.e., less than 25 feet deep), trenches are dug around the area of contamination and then these trenches are backfilled with a soil (or cement) bentonite slurry which once hardened, provides a barrier to groundwater flow. Deeper slurry walls (i.e., greater than 25 feet deep) require specialized equipment, such as a clamshell or dragline attached to a crane, to dig the trench. During deeper excavations, the slurry is introduced into the trench during excavation to prevent the sidewalls of the trench from collapsing.

Effectiveness - This option could effectively reduce the mobility of contaminants by preventing their migration in groundwater. Although the slurry walls themselves do not provide treatment of the groundwater, they can be used in conjunction with extraction wells to enhance recover of the contaminated groundwater which then can be transported to a remedial treatment system where toxicity is reduced.

Implementability - Construction of shallow slurry walls (i.e., less than 25 feet deep) is a conventional technology. Hydraulic excavation equipment, such as backhoes or track excavators, are used to dig the trench. Sheeting and shoring techniques can be employed to maintain the integrity of the excavation walls. Slurry excavation (e.g., introduction of slurry into the excavation during soil removal) techniques are also employed. Construction of deeper slurry walls (i.e, greater than 25 feet deep) involves the used of more specialized equipment. Clamshells or dragline may be employed, depending on the desired depth. Equipment of this type would require more working space when compared to hydraulic excavation equipment. The level of effort, and commitment of resources increases dramatically with depth of the trench.

Costs - Costs for this option are expected to be moderate to high, depending on the depth of the slurry wall.

Recommendation - This option will be retained for further consideration.

3.3.1.5.2 Interceptor Trenches

Description - Interceptor trenches are deep narrow ditches which are excavated into the groundwater saturated zone. The ditches are outfitted with perforated pipe (usually placed at the bottom of the trench) and then backfilled with a porous media. Contaminated groundwater which percolates into this porous media is collected in the pipes and can then be pumped or passively routed to a final remedial treatment system where contaminants can be removed. An impermeable liner can be constructed on one wall of the trench to prevent infiltration from one side of the trench, and to prevent water from passing through the trench.

Effectiveness - Interceptor trenches can effectively reduce the mobility of contaminants by preventing their migration in groundwater. They are particularly effective when interception is required from only one direction. Keying the bottom of the trench into a low permeability geologic unit minimizes the flow of groundwater underneath the trench. When properly designed and installed, this option can be as or more effective than vertical extraction wells. This technique provides a mechanism for the collection of the contaminated groundwater so that it may be routed to a remedial treatment system.

Implementability - Implementation of this option employs conventional construction techniques. Installation requires heavy earth working equipment, and relatively level (less than 12% slope) ground. The construction of interceptor trenches using conventional excavation equipment is generally limited to a depth of 25 feet. As with slurry walls, interceptor trenches deeper than 25 feet can be installed, although specialized equipment and more available space are necessary.

The level of effort, and commitment of resources increases dramatically with depth of the trench. The volume of water captured from an interceptor trench can be substantially less than an equivalent vertical extraction well system because the trench only collects water from one direction.

Costs - The capital costs associated with this option are expected be high, while the O&M costs are expected to be low.

Recommendation - This option will be retained for further consideration.

3.3.1.6 Surface Water Diversion

3.3.1.6.1 Grading

Description - Grading is a technique for controlling surface water by artificially modifying the contour of site soils in an attempt to control water runon and runoff.

Effectiveness - Grading can effectively reduce contaminant mobility by controlling runon and runoff from contaminated surface soils. Altering surface runoff patterns can have effects on sensitive ecosystems which rely on such water sources. For example, significant impact to the natural wetlands may occur if significant volumes of water were diverted away from the area (e.g., diverting the unnamed tributary).

Implementability - Grading is a well-established and conventional technology, however, it does require a substantial amount of heavy equipment and machinery. Also, it may be difficult to implement this option in areas of the site where existing plant structures prohibit the manipulation of site contours.

Costs - The costs of this option will be relatively moderate.

Recommendation - This option will be retained for further consideration.

3.3.1.6.2 Dikes/Berms/Swales

Description - Construction of dikes, berms, or swales is a technique of controlling surface water runoff without severely altering the site contour or significantly affecting overall site drainage patterns.

Effectiveness - This technology would limit the mobility of the contaminants in surface soils through control of surface water drainage pathways to prevent undesirable runoff patterns.. If combined with a collection and treatment system, this option also can provide for the removal of contaminants and the reduction of surface water toxicity.

Implementability - This option is a conventional technology, and would require heavy equipment and machinery. This option could be implemented in many confined areas of the plant, and should not be detrimental to wetlands environments.

Costs - The costs of this option will be moderate.

Recommendation - This option will be retained for further consideration.

3.3.1.7 Surface Water Collection

3.3.1.7.1 Surface Sumps/Pumps

Description - Surface sumps and pumps are used to collect surface water from various areas of the site and to transport it to a treatment system. Surface water sumps and pumps would be implemented in conjunction with a surface water diversion technology if treatment of surface water would be required.

Effectiveness - Surface sumps represent an effective means of surface water collection and transport.

Implementability - Installation of sumps and pumps is a conventional technology. A water conveyance system could require construction of pipelines if contaminated water is transported from the northern portion of the site for treatment at the SCD facility.

Cost - Costs for this option are expected to be moderate.

Recommendation - This option will be retained for further consideration.

3.3.1.7.2 Surface Impoundments

Description - This option would entail the construction of a surface impoundment (pond) for the storage of collected surface water prior to discharge. Suspended solid would be allowed to settle in this impoundment. This surface impoundment should not be confused with the existing sedimentation basin, whose purpose is to hold the contaminated sediments that were removed from the unnamed tributary during previous site response actions. This option would be necessary only if surface water is collected.

Effectiveness - A surface impoundment would allow the suspended solid to settle prior to the discharge of collected surface water. The collected sediments could then be handled appropriately.

Implementability - Construction of a surface impoundment would utilize conventional construction techniques. There is currently not enough space available on the SCD plant site for implementation of this option. The space occupied by the existing sedimentation basin (the only space potentially available for a surface impoundment) is expected to be used for other remedial activities.

Cost - The costs for this technology would be high.

Recommendation - Due to high costs and space limitations, this option will not be retained for further consideration.

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3.3.1.8 Biological Treatment

3.3.1.8.1 Aerobic/Anaerobic Treatment

Description - Aerobic and anaerobic treatment processes involve the use microorganisms to mineralize or dechlorinate the toxic organic compounds within the surface water and groundwater. During the process, the organisms utilize the contaminants as carbon and/or energy sources. Nutrients, in the form of ammonia salts, phosphorous salts, or phosphates are often added as amendments.

Effectiveness - Microbial destruction of organic compounds is a well-established and conventional technology, but may not be effective on the chlorinated benzene compounds identified at the site. Aerobic biodegradation has been demonstrated for some chlorinated benzenes, in which case the end products also include chloride (Sander, 1991, Oltmanns, 1988, Ecova, 1990). In general, the ability to be aerobically mineralized lies primarily in the simpler chlorinated benzenes, notably monochlorobenzene (MCB). Some of the more highly substituted chlorinated benzenes appear to be relatively resistant to aerobic biodegradation. However, at least some of the tetrachlorobenzenes also appear to be aerobically biodegradable (Sander, 1991). To further evaluate the effectiveness of biological treatment, a treatability study is currently being conducted.

Implementability - Biological treatment is a conventional technology for a wide variety of organic compounds. It requires the selection of an aerobic or anaerobic processes and then proper design and operation to maintain the desired conditions. Information gathered from the further study of this option will identify site-specific implementability issues.

Cost - The costs for biological treatment are expected to be moderate to high.

Recommendation - This option will be retained for further consideration.

3.3.1.9 Chemical/Physical Treatment

3.3.1.9.1 Air or Steam Stripping

Description - Air stripping is a mass transfer process that typically utilizes a cylindrical vessel containing high surface-area packing. Air and water flow concurrently through the packing media. This enhances air/liquid contact by exposing a greater amount of liquid surface area to the air. The more surface area exposed the greater the efficiency, because mass-transfer occurs at the gas-liquid interface. The air carries the contaminants out of the stripper. During steam stripping, steam is substituted for air. Air stripping is currently in use at the site for treatment of extracted groundwater.

Effectiveness - This technology has already been demonstrated as an effective method for the removal of target contaminants from the extracted groundwater at the site.

Implementability - Air stripping is a conventional technology requiring minimal space, and is already in use at the plant. The system presently discharges the vapor stream into the plant boiler for thermal destruction, and the liquid stream is added to the plant cooling water. The existing system should be capable of handling additional hydraulic load. The system is designed for 300 gpm while the current loading is generally below 150 gpm.

Cost - The costs for air and steam stripping are considered to be low to moderate.

Recommendation - This option will be retained for further consideration.

3.3.1.9.2 Carbon Adsorption

Description - Carbon adsorption is a treatment process by which a contaminated liquid or vapor is passed over a bed of activated carbon particulates which extract the organic contaminants by adsorption onto the surface of the carbon. When the surface of the carbon becomes saturated (or "spent"), the carbon is regenerated by the use of heat or steam.

Effectiveness - Carbon adsorption is expected to be an effective treatment option for removing chlorinated benzenes from both liquid and vapor phases. Carbon adsorption has shown removal efficiencies greater than 95 percent.

This technology is often selected as a polishing technique in conjunction with other treatment technologies due to the high removal percentages attainable with carbon adsorption.

Implementability - Carbon adsorption is a conventional technology for organic contaminants applicable to both liquid and vapor phase waste streams. In the adsorption process, the carbon becomes "spent," and must be either replaced or regenerated. Onsite regeneration of the carbon is possible, however, this does result in an elutriate waste stream which must be managed or reused.

Cost - Costs for carbon adsorption are considered moderate when used as a polishing technology and high when used as a primary treatment technology.

Recommendation - This treatment option will be retained for further consideration.

3.3.1.9.3 Advanced Oxidation

Description - Advanced oxidation is a somewhat innovative technology in which chemical agents such as hydrogen peroxide or ozone are used to oxidize the organic contaminants in the waste stream. Often, ultraviolet light is utilized to accelerate the reaction.

Effectiveness - In the advanced oxidation process, mobility and toxicity are reduced due to the fact that contaminants are not only removed from the waste stream, but are also destroyed in the process. Unfortunately, this effectiveness is subject to upsets resulting from changes in the influent characteristics.

Implementability - Before this technology can be implemented, treatability tests must be conducted to ensure that cleanup criteria can be attained. Also, excessive turbidity may prevent the penetration of the ultraviolet light if it is used.

Cost - The costs of advanced oxidation are considered to be moderate to high.

Recommendation - This treatment technology will be retained for further consideration.

3.3.1.10 Offsite Treatment

3.3.1.10.1 RCRA Facility

Description - Offsite disposal of the wastestreams would involve the transport of contaminated liquids to a RCRA approved facility for treatment and disposal.

Effectiveness - This option would only be effective if a facility could be identified which would meet all applicable regulations and performance standards required for the particular hazardous waste. In addition, reduction of TMV would be dependent upon the treatment technology employed by the facility.

Implementability - To implement this option, a properly permitted hazardous waste hauler and RCRA approved disposal facility would need to be identified. The identified facility would then need to agree to accept the waste at the site. This option becomes impractical for large volumes of waste.

Cost - The costs associated with offsite disposal are expected to be high.

Recommendation - Due to the large volumes of contaminated liquids expected to be treated at the site and the excessive costs of offsite disposal, this treatment option will not be retained for further consideration.

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3.3.1.11 In Situ Treatment

3.3.1.11.1 In Situ Bioreclamation

Description - In situ bioreclamation is a treatment technology in which nutrients are added to the contaminated groundwater in an attempt to stimulate the natural biodegradation that is occurring within the aquifer.

Effectiveness - As with other biological treatments studied in this FS, there are studies indicating the potential for the biodegradability of chlorinated benzenes. The effectiveness of an in situ implementation of biological treatment will be dependant on several factors: the ability to deliver, in appropriate concentrations, the required amendments to the entire effected area, the ability of the microbes to metabolize the contaminants under in situ conditions, and the ability to withdraw the amendments. Often, documenting effective treatment is extremely difficult and requires extensive monitoring.

In situ biodegradation is expected to have limited effectiveness on the DNAPL present in the Columbia Formation at the SCD site. Typically, the microbes metabolize those contaminants in solution. Therefore, the degradation of the DNAPL would be expected to be solubility-limited. Field treatability studies would be required to determine the effectiveness of this technology.

Implementability - Treatability tests are required to assess the site-specific effectiveness of this technology. The geologic conditions at the site appear to be conducive to the extraction and reinjection of the nutrients. This technology may be employed in conjunction with the extraction and reinjection of the groundwater.

Cost - The costs associated with in situ bioreclamation are considered to be moderate.

Recommendation - This option will be retained for further consideration. This recommendation will be updated pending the results of the biological treatability study being performed concurrently with this FS.

3.3.1.11.2 Chemical Reaction

Description - Chemical reaction is an in situ version of advanced oxidation in which an oxidizing agent such as hydrogen peroxide is injected into the aquifer via a series of injection wells.

Effectiveness - Limited data exists on the effectiveness of the in situ chemical reaction process. The effectiveness issues discussed for in situ biodegradation would also apply to this option. The injection of oxidizing agents requires strict control of groundwater extraction prior to discharge to the unnamed tributary and Red Lion Creek. Treatability studies would be require to determine the ability of oxidizing agents to destroy the contaminants found in groundwater.

Implementability - The implementability of this option is governed mainly by site geologic conditions, which appear to be favorable for injection and extraction of the oxidants. Treatability studies would be necessary to determine the implementability of this option at the SCD site.

Cost - The costs associated with chemical reaction would be moderate to high. The oxidizing agent chosen, and the amount of oxidizer required will greatly affect the cost.

Recommendation - This option will be retained for further consideration.

3.3.1.12 Discharge Technologies

3.3.1.12.1 Discharge to Local Stream

Description - This option would involve discharge of treated groundwater to one of the local streams such as Red Lion Creek, the unnamed tributary, or the Delaware River. This option would be performed in conjunction with a treatment technology.

Effectiveness - Discharge of treated groundwater to a local stream is widely used at other sites. The effectiveness of this option will be determined by the extent of treatment provided by the selected treatment system.

Implementability - This disposal option will require pretreatment before discharge. Selection of this option will require the acquisition of a National Pollution Discharge Elimination System (NPDES) permit. Currently, the plant is operating under an NPDES permit, allowing discharge to the Delaware River.

Cost - The cost for this option is expected to be low. This assumes that discharge would be through the existing effluent pipeline.

Recommendation - This discharge option will be retained for further consideration.

3.3.1.12.2 Groundwater Injection

Description - This option involves reinjection of treated groundwater into the Columbia or Upper Potomac aquifer.

Effectiveness - The effectiveness of this option will be determined by the level of treatment attainable by the specific groundwater treatment option selected.

Implementability - This disposal option will require treatment to reduce the contaminant concentrations to acceptable levels for groundwater recharge. Such injection would require evaluation to ensure that the injected effluent will not detrimentally affect contaminant migration in groundwater. A discharge permit will be required if this option is selected.

Cost - The costs for groundwater injection are expected to be low.

Recommendation - This option will be retained for further consideration.

3.3.1.13 Treatment Technologies Using Innovative Technologies

3.3.1.13.1 Mechanical Vapor Recompression Evaporation

Description - Mechanical vapor recompression evaporation (MVR) is an emerging technology used to enhanced evaporation and thermal stripping technologies. The aqueous waste stream is boiled off in an evaporator and compressed 1 to 3 psi. This raises the vapor temperature allowing it to be used as the heating medium in the evaporator. The vapor stream is then condensed, separating out the non-aqueous phase.

Effectiveness - MVR is best applied to aqueous streams heavily contaminated with iron, oil and grease, semivolatile compounds, or other materials which would quickly foul processes such as air stripping, granular activated carbon adsorption, and ion exchange. MVR is not, of itself, an efficient process for the remediation of low concentration aqueous streams, rather it enhances processes such as thermal stripping and evaporation. When properly applied, MVR will perform an effective separation of the aqueous stream into aqueous and non-aqueous fractions.

Implementability - MVR has been applied to steam stripping for the removal of volatile organics, and pentachlorophenol. No information regarding its applicability to chlorinated benzenes was available. As this process enhances thermal stripping and evaporation, those technologies are required for its application.

Cost - The costs associated with this technology are expected to be to high, primarily due to expected high capital costs.

Recommendation - This option will not be retained for further consideration.

3.3.1.13.2 Adsorption Using Synthetics

Description - This option is similar to carbon adsorption except that specialized adsorptive media are substituted for carbon. The influent liquid passes through the adsorptive media, where organic compounds are adsorbed. Specialized adsorption media are employed, and can be engineered specifically for the site contaminants.

Effectiveness - This technology is capable of removing contaminants from both liquid and vapor phase media. Typically removal percentages are comparable to carbon, although the adsorptive capacity (pounds contaminant removed per pounds of adsorptive media) of the synthetics is higher. As with carbon adsorption, this technology is often used in conjunction with other treatment technologies.

Implementability - Before incorporating this treatment option, treatability testing would be required to determine what removal efficiencies could be expected. Periodic regeneration of the synthetic adsorbent would be required. Onsite regeneration is generally employed for cost purposes.

Cost - The costs associated with this option are expected to be moderate to high. This technology would be expected to have higher capital costs than carbon adsorption, although, due to increased adsorptive capacity, the O&M costs are expected to be lower.

Recommendation - This option will be retained for further consideration.

3.3.2 Soils and Sediments Technologies

3.3.2.1 No Action

Description - Under the no action alternative, the contaminated soils and sediments would be left in place at the SCD site. This would include those soils and sediments contained within the soil piles and the sedimentation basin.

Effectiveness - No significant reduction in toxicity, mobility, or volume would be expected from this option, except those from natural attenuation.

Implementability - This option would require no effort to implement, as it requires no remedial ction, and no commitment of resources.

Costs - There are no costs associated with this option.

Recommendation - This option will be retained for further consideration as required by the NCP.

3.3.2.2 Institutional Action

3.3.2.2.1 Deed Restrictions

Description - Deed restrictions are institutional controls that limit the permissible future uses of the property, and alert prospective property buyers to the presence of hazardous substances at the site. Deed restriction would likely preclude the use of the land for future residential or recreational development, and restrict use of the adjacent wetlands for recreational purposes (e.g., hunting).

Effectiveness - Establishing deed restrictions will limit access to the contaminated property which in turn will reduce contact with and exposure to the contaminants. This option, however, will not provide for the reduction of toxicity, mobility, or volume of the contaminants at the site, as it involves no remedial activities. The ultimate effectiveness of this alternative relies upon continued future enforcement of these restrictions.

Implementability - The deed restriction option are generally easy to implement. These administrative and legal procedures are widely implemented at hazardous waste sites.

Enforcement of restricted use of the wetland areas may be particularly difficult. Posting warning signs at regular intervals would notify the community of the restrictions, but would not prevent unauthorized access.

Costs - The costs of this option would be low.

Recommendation - This option will be retained for further consideration.

3.3.2.3 Site Security

3.3.2.3.1 Fencing

Description - This options involves the installation of security fences around the portions of the site to prevent unauthorized access.

Effectiveness - Installation of a fence around the perimeter of the site will limit exposure to the contaminants by restricting access to the restricted areas. This option will not provide any reduction in toxicity, mobility, or volume of the contaminants in soils or sediments, expect those from natural attenuation.

Implementability - Fencing is a widely used component of most remedial alternatives. Much of the site is already enclosed by fencing, therefore, reducing modifications or expansions that may be necessary. This technology could be very easily implemented at the SCD site.

Cost - Costs for this option are expected to be low.

Recommendation - This option will be retained for further consideration.

3.3.2.4 Monitoring

3.3.2.4.1 Wetlands Monitoring

Description - Wetlands monitoring would involve periodic inspections of the wetlands by an ecologist or biologist.

Effectiveness - This option would provide decision-makers with early warning of possible changes in site considerations that may warrant reevaluation of remedial strategy.

Implementability - Monitoring is a common component of remedial action alternatives. The option would require minimal commitment or resources.

Cost - The costs associated with this option are expected to be low.

Recommendation - This alternative will be retained for further consideration.

3.3.2.5 Removal

3.3.2.5.1 Excavation

Description - Excavation of soils and sediments would involve the use of heavy machinery to physically remove contaminated soils. For the purposes of this FS, excavation will include removal of the contaminated soils and sediments in the sedimentation basin. This technology would be used in conjunction with a treatment, storage and disposal technology.

Effectiveness - Removal of the contaminated soils by excavation would be an effective initial step in the treatment of the soils. Removal of the soils limits the mobility of the contaminants by preventing further migration.

Implementability - Excavation is a widely-used conventional construction technique. Excavation is generally limited to a depth of 25 feet, beyond which excavation is no longer practical. This option is not applicable to areas where existing structures or process apparatus obstruct the access of excavation equipment to the target soils.

Cost - The cost associated with this option are expected to be low. Extending the depth of excavations below 25 feet would significantly increase the expected cost.

Recommendation - This option will be retained for further consideration.

3.3.2.5.2 Dredging

Description - Dredging techniques utilize special equipment to remove sediments from areas where the presence of water prevents the use of excavating equipment. Several methods of dredging are commonly used including: mechanical, hydraulic, and pneumatic.

Effectiveness - Dredging can provide an effective means for sediment removal, although there are several drawbacks associated with the technology. There are several factors that must be evaluated prior to initiating dredging activities. First, the impact of sediment removal from a wetland area must be considered. As sediment is extracted, vegetation and root systems are often removed with the sediment. Second, sediment transport during dredging must be controlled. During dredging activities, sediments are often put into suspension. Proper implementation of sediment barriers is required to prevent migration of these suspended sediments. Third, the volume of sediment generated can be substantial. Often dredging techniques withdrawal the sediment in a slurry, containing as little as 10 percent solids (by weight). For example, to remove 1,000 tons of sediment, 10,000 tons of slurry are removed. This represents a substantial increase in the amount of material requiring treatment. Finally, regrading and reseeding of the dredged areas is often required as a restoration step after dredging operations. The effectiveness of these techniques is variable and may change the natural conditions of the wetlands.

Implementability - Dredging is a common sediment removal technique that in recent years has been employed for the removal of contaminated sediments. Dredging of contaminated sediments in the areas of concern in the Unnamed Tributary and Red Lion Creek could be implemented at the SCD site. Due to the lateral reach limitations of some dredging techniques, construction of temporary platforms or roads in the wetlands may be required to facilitate access to the designated removal areas.

Sediment control barriers could be easily employed to minimize sediment runoff during dredging activities. Water and contaminated sediment slurries generated from the dredging process may require the use of a settlement basin and/or dewatering mechanisms to allow sediment separation from the slurry and to reduce water content prior to sediment containment or treatment.

Cost - The costs of this option is expected to be moderate to high.

Recommendation - This option will be retained for further consideration.

3.3.2.6 Capping

3.3.2.6.1 Soil Covers

Description - Basic soil covers involve the placement of clean backfill over contaminated soils. These covers are graded to minimize runon and enhance the runoff of precipitation. The soil covers are typically revegetated to prevent erosion. These cover systems do not necessarily employ low permeability soils.

Effectiveness - Basic soil covers can be effective at limiting infiltration, and ultimately, in reducing contaminant mobility within the soil. In addition, basic soil covers reduce the potential for direct exposure (through ingestion, contact, and inhalation) with the target soils.

Implementability - Basic soil covers are a widely used technology applying conventional construction techniques. They are relatively easy to implement. Steep grades add difficulty to design and implementation. Basic soil covers are not applicable to wetland areas as they would adversely impact these sensitive ecosystems.

Cost - The costs associated with this option would be relatively low.

Recommendation - This technology will be retained for further consideration.

3.3.2.6.2 Low Permeability Soil Caps

Description - Low permeability soil caps are a superset of basic soil covers. These capping systems utilize a mulitlayer design. Typical designs include (from bottom to top) a low permeability soil, a lateral drainage layer, and a final soil cover.

Effectiveness - The effectiveness of low permeability soil caps is expected to be higher than with basic soil covers. The low permeability soils more efficiently limit the infiltration of water compared to basic soil cover. Efficiencies of greater than 90 percent can be achieved with proper design and installation.

Implementability - The implementability of low permeability caps requires more effort and design to implement than the basic soil covers. Steep grades add difficulty in design and installation.

Cost - The costs associated with this technology are expected to be low to moderate.

Recommendation - This technology will be retained for further consideration.

3.3.2.6.3 Synthetic Membrane Liners

Description - Synthetic membrane liner (SML) capping systems are basically the same as low permeability capping systems except that an SML is substituted for the low permeability soil. Common SMLs include: high density polyethylene (HDPE), low density polyethylene (LDPE), and polypropylene.

Effectiveness - Like low permeability soils, SMLs can be very effective at preventing infiltration and the runoff of contaminants and, as a result, reducing mobility of the target contaminants. SMLs are most effective when a low permeability soil is placed directly underneath the SMLs. This is done as a safeguard to combat construction and material defects that result in pinhole leaks and seam tears.

Implementability - Synthetic liners require more effort to implement than low permeability soil caps. Specialized equipment is required to make the necessary welds to join two pieces of SML. Other implementable discussed for low permeability capping systems are also applicable to SML systems.

Cost - The costs for synthetic membrane liners can be moderate to high.

Recommendation - This technology will be retained for further consideration.

3.3.2.6.4 Asphalt/Concrete Caps

Description - The use of asphalt or concrete covers involves covering the contaminated soil areas with a layer of asphalt or concrete to prevent infiltration.

Effectiveness - Like the other capping systems, asphalt and concrete covers can reduce contaminant mobility by preventing infiltration and runoff, and can reduce the chance of direct contact with the target soils. In addition, asphalt and concrete are more resistant to the erosion problems which occur with soil covers.

Asphalt and concrete capping system are subject to cracking and deteriorization over time which may affect the integrity of the system. It is not possible to revegetate those areas that are capped, making this option unattractive in the offsite areas.

Implementability - Asphalt and concrete soil caps are readily implemented using conventional construction techniques. Steep grades add difficulty in design and installation.

Cost - The costs of asphalt/concrete caps can be moderate to high depending upon the size of the area to be covered.

Recommendation - This technology will be retained for further consideration.

3.3.2.7 Sediment Barriers

3.3.2.7.1 Geofabrics/Erosion Mats

Description - Geofabrics and erosion mats are synthetic materials that are placed directly onto sediments. These materials trap sediments into a web-like matrix, thus reducing their movement.

Effectiveness - In principle, these fabrics should prevent the migration of sediments. Little information exists regarding the use of this technology. It would be expected that the long-term reliability of technology would be problematic, as vegetation eventually works its way through the fabric, compromising the integrity of the barrier. This would require investigation prior to implementation.

Installation of these mats would require devegetation of the wetlands, thus having an adverse impact to these sensitive areas. The fabrics also would be expected to hinder the growth of vegetation once installed. These fabrics act in a similar manner to weed mats, commonly used in gardens to prevent the growth of weeds.

Implementability - Numerous geofabrics are available commercially through vendors, however, materials specifically designed for use as sediment erosion barriers have not been identified. Installation of a fabric, once identified, would require clearing the wetlands of vegetation. The fabric would then be placed directly onto the sediments, and anchored if necessary.

Cost - The costs associated with the geofabrics/erosion mats option is expected to be moderate.

Recommendation - Due to the uncertainty as to their long-term durability and the detrimental effects this technology would have on wetlands, this technology will not be retained for further consideration.

3.3.2.7.2 Aggregate Materials

Description - Aggregate materials consist of stones, of varying sizes, that are placed onto the sediments to prevent their movement. Aggregate materials are commonly placed in drainage ditches to prevent erosion.

Effectiveness - Utilization of aggregate materials can be effective at reducing erosional mobility of target compounds. Changes in drainage patterns resulting from the use of aggregate materials could have detrimental effects upon the nearby wetlands.

Implementability - Implementation of this option would not be very difficult. This option utilizes conventional materials, and installation techniques are well-established. Following the initial placement of the materials, occasional maintenance and inspection of drainage pathways would be required to monitor erosion and changes in flow paths.

Cost - The costs for implementing the aggregate materials option are low.

Recommendation - This option will be retained for further consideration.

3.3.2.8 Thermal Treatment

3.3.2.8.1 Incineration

Description - Incineration involves the high-temperature oxidation of the contaminated materials to provide destruction of target compounds. Temperature in excess of 1600°F are typically employed. Combustion byproducts would include CO_2, H_2O, and HCl. Several common variations of incineration are commercially available including: rotary-kiln incineration, infrared incineration, and fluidized bed incineration.

Effectiveness - Incineration has been shown to be an effective and permanent treatment solution, capable of providing 99.99% destruction removal efficiency (DRE) as required by RCRA.

Incineration effectively reduces toxicity, mobility, and volume of the contaminated waste streams.

RCRA standards also limit the HCl emissions that are permissible during incineration to 1.8 kg/hr in the stack gas prior to entering any pollution control device. Due to the high chlorine content in some of the waste streams (e.g., soil piles, sediments in the sedimentation basin), this standard may be difficult to meet.

Implementability - Both mobile and stationary units are available commercially. Implementation of the incineration option may require pretreatment or modification of the waste feed system to accept wastes with high moisture or chlorine contents. In addition, air emissions controls are required during operation of the incinerator. Following incineration, treatment residuals could be backfilled after being delisted.

Despite poor public perceptions of the process, incineration is a widely accepted technology for the destruction of organic compounds. This arises from public concerns over air emissions generated during incineration activities. Of particular concern are the products of incomplete combustion.

Cost - Incineration is a very energy intensive technology and as a result, the costs are expected to be high.

Recommendation - The incineration option will be retained for further consideration.

3.3.2.8.2 Thermal Desorption

Description - Thermal desorption is the heat-induced desorption, volatilization, and capture of volatile and semi-volatile organic compounds from contaminated solids. Temperatures utilized range from 200°F to 900°F. Unlike incineration, the contaminants are not destroyed, rather they are removed from the waste, collected, and concentrated in the vapor treatment system. This concentrated product phase could then be reused by the plant.

Effectiveness - Thermal desorption would be an effective permanent treatment solution. Lab-scale treatability studies have already been performed, and show 99.9-99.999% DRE of target compounds using site soils and sediments. Recovery and reuse of the product phase also reduces the volume of treatment residuals requiring further management.

Implementability - Thermal desorption is an accepted technology for treatment of volatile and semi-volatile organic compounds. Although not widely available, transportable and stationary units are available from a few vendors. A high moisture content in feed materials may require feed system modification or pretreatment. The energy requirements of the process are directly related to the moisture content of the feed material. Overall, the process is less energy intensive than incineration due to lower operating temperatures. It is expected that the solid residuals could be backfilled on-site after treatment and delisting.

Cost - The costs for thermal desorption technology are expected to be moderate to high.

Recommendation - This technology will be retained for further consideration.

3.3.2.9 Chemical Treatment

3.3.2.9.1 Dechlorination

Description - Dechlorination is a chemical treatment process for the removal of chlorines from aromatic hydrocarbons. This process involves the removal of chlorine atoms from chlorinated organics by chemical reaction with a reagent. The potassium polyethylene glycol (KPEG) process is a well-known chemical dechlorination technology.

Effectiveness - Chemical dechlorination has been demonstrated in field scale studies to be effective on chlorinated aromatic compounds, specifically PCBs, pentachlorophenol, and dibenzo-dioxins. Treatability studies concerning the effectiveness of the process on chlorinated benzenes were not identified, however chlorinated benzenes are similar in chemical structure to those compounds treated.

The treatment residues, including the treated solids, and the excess reagents, are expected to require further treatment. The toxicity of the treated solids would require evaluation, as would the disposal options.

Implementability - Commercial systems for dechlorination are available, although systems capable of handling large volumes of material may not be available. The space required for a large scale reactor is unknown. It is expected that the proper stoichiometry will be difficult to maintain for heterogeneous feeds.

Cost - The costs of the chemical dechlorination are expected be moderate to high.

Recommendation - This treatment technology will not be retained for further consideration.

3.3.2.10 Physical Treatment

3.3.2.10.1 Stabilization and Solidification

Description - Stabilization/solidification involves the addition of stabilizing agents to convert and maintain the contaminants to their least mobile state. This is performed either through the removal of moisture within the waste material, or forming chemical bonds with the contaminants in the waste material. Several types of stabilization processes are available including: cement-based, pozzolanic, thermoplastic, and organic polymerization.

Effectiveness - The purpose of this technology is to reduce the mobility of the contaminants. Both in situ and ex-situ processes are available, however, the effectiveness of the in situ technology can be difficult to measure. Often heterogeneity of the site soils can be an obstacle to in situ treatment. Treatability studies are required to determine: the optimal stabilizing agent, the proper additive ratio, and the leachability of stabilized materials.

Implementability - Stabilization processes are available from several vendors for both ex situ or in situ application. The practical limit of in situ stabilization is 10 feet. Ex situ application requires space for process equipment, material staging, and post-treatment disposal (if applicable). The associated volume increase that is expected during stabilization requires consideration for any disposal options.

Cost - The costs for this option are expected to be low to moderate

Recommendation - This option will be retained for further consideration.

3.3.2.10.2 Solvent Rinsing/Soil Washing

Description - Solvent rinsing involves contacting the contaminated materials with an appropriate solvent, thereby solubilizing and removing the contaminants. Soil washing generally employs water as the solvent (with other additives), and separate the soils based on particle size. Often contaminants are preferentially sorbed to the fine particles within the soil. Therefore, this separation process results in a smaller volume (the fines) of high concentration soils. A contaminated aqueous or solvent waste stream is generated using either process.

Effectiveness - The effectiveness of solvent rinsing is dependent upon several factors including: the solubility of the contaminant in the solvent, the strength with which the contaminants are bound to the soils, the toxicity of the solvent, and the ability to remove the solvent from the soils. Solvents may be more effective than water, but are toxic and may be difficult to remove from treated soils, and would require additional treatment to remove these residual solvents. Additional treatment would be required to remove these residual solvents.

The removal efficiency of soil washing has been reported at 90 percent (EPA, 1992). This efficiency may not be acceptable to treat many of the soils at the site (e.g., soil piles, on-site surface soils), as the result soil may not be acceptable for use as backfill. In addition, sediments contain a high percentage of fine particles, and therefore treatment may not result in significant volume reduction. In any event, the resultant high concentration fines would require additional treatment using another treatment technology.

Implementability - Solvent rinsing/soil washing is a rapidly emerging technology, with a variety of proprietary processes available. The processes may be impractical for highly contaminated materials since the high concentrations may require several successive rinses. In addition, removal of the solvent or other treatment additives from the treated materials may be difficult. Both solvent rinsing and soil washing would require available space for setup and staging of materials, and require standard utility service (i.e., electricity and water).

Cost - The costs for this treatment technology would be low to moderate; additional cost would be incurred for final treatment of the washing/rinsing residuals.

Recommendation - Due to the concerns regarding the effectiveness of this technology, this technology will not be retained for further consideration.

3.3.2.11 Biological Treatment

3.3.2.11.1 Solid Phase Biological Treatment

Description - Solid phase biological treatment, commonly implemented as composting, involves the ex situ treatment of contaminated materials with microorganisms which can use the target compounds as carbon and/or energy sources. Nutrients, in the form of ammonia salts, phosphorous salts, or phosphates are often added as amendments. Solid phase biological treatment can be performed under aerobic, and anaerobic conditions. To develop and maintain anaerobic conditions, soil piles are placed into cells several feet deep, and are not tilled. Aerobic treatment usually employs cells a few feet deep, and air is introduced to the materials by periodically tilling or mixing the soils.

Effectiveness - The issues concerning the effectiveness of biological treatment in general are discussed in Subsection 3.3.1.8.1. As stated in this subsection, a treatability study is currently being conducted to further evaluate the effectiveness of biological treatment. Information regarding the applicability of biological treatment to the materials at the site will be incorporated as they become available.

Implementability - Solid phase biological treatment is a conventional treatment technology for many organic compounds. The process usually involves excavation of soils to specially designed cells for batch processing. As stated, the construction and operation of these treatment cells varies depending on whether aerobic and/or anaerobic conditions are desired. The reaction rate of this process is expected to be relatively slow.

Cost - The costs for solid phase biological treatment are considered to be relatively low.

Recommendation - This technology will be retained for further consideration. Results of the treatability study being conducted under the RI/FS program will be incorporated as they become available.

3.3.2.11.2 Slurry Phase Biological Treatment

Description - Slurry phase biological treatment is an emerging technology in which soils are combined with water to create a slurry and stimulate the same biological transformations that occur in solid phase biological treatment.

Effectiveness - Effectiveness issues described in the previous subsection would also apply to slurry phase treatment.

Slurry phase biological treatment is characterized by relatively high reaction rates as compared to solid phase processes, however, the slurry phase will require aqueous phase management and possibly some additional pre- or post-process treatment.

Implementability - Slurry phase biological treatment can be implemented as both a batch or continuous flow process. The relatively high reaction rates make this option attractive to the site. As with solid phase processes, laboratory treatability studies would be necessary.

Cost - The costs of slurry phase biological treatment are expected to be moderate.

Recommendation - This technology will be retained for further consideration. Results of the treatability study being conducted under the RI/FS program will be incorporated as the become available.

3.3.2.12 Offsite Treatment

3.3.2.12.1 RCRA Facility

Description - Offsite treatment and disposal of the contaminated soils and sediments would involve transporting the materials to a RCRA approved facility for treatment and permanent disposal.

Effectiveness - This is a proven, straight-forward approach. The potential exposure to the site contaminants would be permanently reduced. The overall effectiveness of this option would be dependant of the effectiveness of the treatment method employed by the offsite facility. In most cases, incineration is employed by the permitted facility.

Implementability - To implement this technology, a properly permitted hazardous waste hauler and RCRA approved treatment and disposal facility would need to be identified. The identified facility would then need to agree to accept the waste from SCD. The expected volume of material potentially requiring treatment may make this technology impractical.

Cost - The costs associated with the offsite disposal option are expected to be high.

Recommendation - This option will be retained for further consideration.

3.3.2.13 In Situ Treatment

3.3.2.13.1 In Situ Vitrification

Description - In situ vitrification is a process where in situ soils are converted to a durable, glass-like material as they are heated to extreme temperatures. This conversion is achieved by passing an electrical current through subject soils that, in turn, produces temperatures in the 1,600 to 2,000°C range.

Effectiveness - This technology has been developed for full-scale application and is ready for commercial deployment, but it does not have a significant commercial experience base. Large-scale testing has included the successful treatment of soils contaminated with heavy metals, liquid and solid organic compounds, and radioactive materials.

There are several removal processes at work simultaneously in the vitrification process. The heat produced by the electric current will thermally desorb and/or oxidize many of the volatile and semi-volatile organic contaminants in the soil. The remaining contaminants which are not volatilized or destroyed will be encapsulated in a solid glass-like matrix which results from the vitrification of the soil.

Implementability - This technology is very energy intensive. Materials with high moisture contents must first be dried before the vitrification process is initiated. It is unlikely that the process can be applied to areas where there are structures or process apparatus. Nearby metallic objects can interfere with the process. The maximum width that can be treated by each treatment apparatus is 35 feet. The practical depth limitation is approximately 25 feet (EPA, 1991).

Cost - The costs of this technology are expected to be high.

Recommendation - This option will not be retained for further consideration.

3.3.2.13.2 In Situ Biodegradation

Description - In situ biodegradation would involve the injection of nutrients and potentially microorganisms and oxygen into site soils to stimulate the destruction of organic contaminants by microorganisms which utilize the compounds as either a carbon source or an energy source, or both. Spent nutrients and microorganisms are then collected in a groundwater collection system.

Effectiveness - As stated in Subsection 3.3.1.8.1, there is evidence that chlorinated benzene can be degrade by biological activity. This is currently being investigated as part of the biological treatability study being conducted under the RI/FS program.

In situ biodegradation is sensitive to a number of environmental factors including: heterogeneous subsurface conditions, availability of trace nutrients, oxygen concentration, redox potential, pH, degree of water saturation, and temperature. These factors would require monitoring and control during operation.

Implementability - Geologic conditions at the site appear to be conducive for the injection and extraction of nutrients. A groundwater extraction system is currently in use at the site. Treatability studies, specifically directed toward in situ implementation, would be required.

Cost - The costs of in situ biological treatment are expected to be moderate to high.

Recommendation - This technology will be retained for further consideration. Results of the treatability study will be incorporated as they become available.

3.3.2.13.3 Soil Flushing

Description - In situ soil flushing would involve the passing of a selected solvent through the contaminated soil matrix to desorb the organic target compounds, followed by extraction and collection of the spent solvent. This process is similar to solvent rinsing/soil washing except that it is performed in situ. Flushing solutions may include water, acidic solutions (e.g., sulfuric acid, hydrochloric acid, nitric acid, phosphoric acid, and carbonic acid), basic solutions (e.g., sodium hydroxide), and surfactants (e.g., alkylbezene sulfonate) (EPA, 1990).

Effectiveness - Ideally, water would be used as the solvent, however, the high soil/water sorption coefficients of chlorinated benzenes will limit the effectiveness of water as a solvent. Solvents and materials other than water may increase the mobility of the chlorobenzenes and could result in migration of contaminants to other areas of the site or off-site. The effectiveness associated with the use of this technology would be variable and difficult to determine.

The use of solvents and materials other than water make the effectiveness of this option highly dependant on the effectiveness of groundwater extraction. As the chlorinated benzenes are removed from the soils, they are transported to groundwater, thus increasing their concentration in groundwater. In addition, introduction of solvents may jeopardize the confining unit underlying the Columbia Formation. In any event, the groundwater extraction must be capable of extracted these contaminants before they reach the Unnamed Tributary or Red Lion Creek.

Implementability - Implementation of the soil flushing can be difficult, or impossible, if the site geology is not conducive to the injection and extraction of the solvent. It appears that the local geologic conditions are suited to injection and extraction, although field treatability testing is required for confirmation.

Cost - The costs for soil flushing are expected to be moderate to high.

Recommendation - Due to uncertainties regarding the effectiveness and implementability, this option will not be retained for further consideration.

3.3.2.13.4 In Situ Steam Injection/Vapor Extraction

Description - In situ steam injection/vapor extraction is a process that uses steam to desorb contaminants in subsurface soils. Steam, under positive pressure, is forced into the subsurface strata, via injection wells. Vapor extraction wells, operating under negative pressures, are used to collect the steam, and contaminants that have desorbed into the steam. The collected vapors are then treated prior to discharge to the atmosphere. Hot air can be substituted for steam.

Vapor extraction alone (i.e., without steam or hot air injection) is used for soils contaminated with volatile organics.

Effectiveness - In situ steam/hot air injection is an emerging technology. Demonstration of in situ steam/hot air injection is limited to a few field-scale studies. In principal, stream/hot air injection is likely to be effective on volatile and semi-volatile compounds. The ability to introduce, and maintain, heat in the subsurface formations will be the critical factor determining effectiveness.

In situ steam/hot air injection must be tested thoroughly when applied to soils containing high concentration of semi-volatile organics. As the heat source (steam or hot air) contact contaminated soils, the contaminants desorb and volatilize into the vapor stream. As these vapor phase contaminants move further away from the heat source (toward the extraction point), the vapor-phase contaminants begin to cool, and may condense. This condensate could then percolate down in the Columbia aquifer, forming a DNAPL. Based on literature concerning the technology, there is evidence that this phenomena may occur. During a demonstration of this technology, it was acknowledged that semi-volatile compounds were removed from soils, although these compounds were unaccounted for elsewhere in the process (EPA, 1991). Although the presence of condensed organics was not identified during this demonstration, the potential damage to groundwater that could result requires that the technology be carefully and thoroughly investigated prior to implementation. Placing extraction wells close to injection wells might be a way to circumvent this problem.

Vapor extraction has been demonstrated at many site contaminated with volatile organics. It's applicability to soils is generally determined by the permeability of the soils, and the type of the contaminants, and elapsed time from the release (EPA 1991). Vapor extraction is most effective for permeability soils contaminated with high volatility compounds, where a short time period has elapsed since the release. At the SCD site, the sandy soils are conducive to this technology, by the volatility of the contaminants, and the elapsed time since the release decrease the chance of success. Compounds with a vapor pressure greater the 1 mm of mercury at 20°C are generally candidates for vapor extraction (Danko, 1989). Of the site contaminants, trichlorobenzenes, tetrachlorobenzenes, pentachlorobenzene, and hexachlorobenzene have vapor pressures less than 1 mm mercury at 20°C.

Implementability - All forms of this technology are implementable to most portions of the site. This technology is not applicable to wetlands. The major components required for the process include: steam generator(s), injection wells, extraction wells, extraction pump, piping array, and vapor treatment system. Injection and extraction wells can be placed within close proximity to aboveground equipment, and piping arrays can be constructed underground. Other equipment requires little space. Recovered product phase could be reused by the plant, while the liquid waste could be treated with groundwater.

Cost - The costs of this technology are likely to be moderate to high.

Recommendation - Due to the effectiveness problems as described above, this option will not be retained for further consideration.

3.3.2.14 Disposal

3.3.2.14.1 Onsite Secure (RCRA) Landfill

Description - This option for the disposal or consolidation of solid waste residuals would be the construction of a RCRA approved below or aboveground landfill. Disposal of contaminated material is expected to involve excavation/dredging and staging in a secure area. The construction requirement of the landfill would include a double liner system with leachate collection and detection systems. Following "placement", RCRA level closure would be required. It should be noted that placement does not occur when materials are consolidated within an area of contamination (EPA, 1989). This landfill would be constructed in the location of the sedimentation basin.

Effectiveness - Landfilling is a commonly used disposal technology. The technology is an effective means of limiting the mobility and site contaminants, while reducing potential exposure.

Implementability - Construction of landfills employ conventional construction techniques. As stated, the a landfill constructed to RCRA standards requires a multilayer cap, double liner, and leachate collection and detection systems. It is anticipated that the landfill could only be constructed in the location of the sedimentation basin.

Cost - The costs for this disposal option are expected to be moderate to high.

Recommendation - This disposal option will be retained for further consideration.

3.3.2.14.2 Offsite Secure (RCRA) Landfill

Description - Offsite disposal of contaminated soils and sediment involves excavation/dredging, and staging in a secure pad pending final disposal arrangements. The staging pad would be necessary for pretreatment (to remove free liquids at a minimum) prior to transport. Because the materials that are removed are expected to be RCRA-listed wastes, treatment of the materials would be required either onsite or offsite. The offsite landfill must meet all applicable RCRA requirements.

Effectiveness - This is a widely implemented technology. When properly implemented the overall risks to the surrounding community are minimal. The effectiveness of treatment would be dependant on the treatment method used.

Implementability - Offsite disposal is a conventional technology, as there are many RCRA facilities available to accept such residuals. Transporters would have to comply with all applicable DOT and EPA requirements. Due to the volume of material expected, the materials handling could be considerable. Access roads and truck weighing facilities would be required.

Cost - The costs associated with offsite disposal are expected to be high.

Recommendation - This option will be retained for further consideration.

3.3.2.14.3 Nascent State Hydrodechlorination

Description - Nascent state hydrodechlorination is an emerging technology that is similar to chemical dechlorination. Nascent (atomic) state hydrogen is mixed with contaminated soils or sediments, at elevated temperatures. A catalyst is present to speed up the reaction. During the reaction, nascent hydrogen substitutes for the chlorine atoms.

Effectiveness - This technology is still in its infancy; therefore no information is available regarding the technology's ability to dechlorinate chlorinated benzenes. The technology has shown promise with pesticides such as DDT.

If applied to chlorinated benzenes, the compounds resulting from this process can be more toxic than the initial contaminants. For example, the successful dechlorination of monochlorobenzene would result in the production of benzene, which is a classified carcinogen. Similarly, dechlorination of other chlorinated benzenes would result in the production of benzene.

Implementation - This technology is currently in its infancy state. Presently, the process has only been applied to laboratory-scale experiments. Scale-up information would be required from treatability studies.

Cost - The costs associated with nascent state hydrodechlorination are expected to be moderate.

Recommendation - This technology will not be retained for further consideration.

3.3.2.14.4 Advanced Oxidation

Description - Advanced oxidation is an emerging technology in which chemical agents such as hydrogen peroxide or ozone are used to facilitate the oxidation of organic compounds in waste streams. Typically, ultraviolet light is utilized to catalyze the oxidation reaction. This process has been normally applied to aqueous waste stream, although recently its application to solid waste stream has been tested. As a compromise, a slurry can be created by the addition of water to the soil before treatment.

Effectiveness - The oxidation reaction is expected to be effective at destroying the types of compounds which are targeted at the site, however, the technology is typically applied to water treatment and has only recently been tested for solid phase contamination. Treatabilities studies would be required to determine the effectiveness for site materials.

Implementability - The advanced oxidation process can be conducted as a batch or continuous flow process. As with other ex situ processes, excavation/dredging, and staging of the contaminated materials would be required. Upon successful treatment, the materials could be delisted and used as backfill or consolidated onsite.

Cost - The costs associated with advanced oxidation are likely to be high.

Recommendation - Pending full-scale implementation of this technology, this option will not be retained for further consideration.

3.3.2.14.5 Plant Uptake

Description - Plant uptake is a technology still in its infancy state. Specially selected or engineering flora are established in a contaminated area where they assimilate contaminants. These contaminants are then metabolized, or immobilized in the plant. In the case of immobilization, the plant is removed for final disposition.

Effectiveness - Limited data currently exists regarding the effectiveness of the plant uptake technology. Studies have focussed on the effect of plant uptake on metals and toxaphene. Studies involving chlorinated benzenes could not be located. Due to the high concentrations found in sediments, it is expected that this technology would not be able to meet remedial action objectives. Treatability studies would be required to determine the effectiveness of the technology.

Implementability - There would not seem to be any technical restrictions to the application of this technology at the site. Application of vegetative species to the surrounding wetlands should not adversely effect these ecosystems, provided a suitable plant species could be located. Maintenance of the plants would be required. This might involve periodic removal of dead plants, and replanting.

Cost - The cost to implement this option is expected to be low.

Recommendation - Due to effectiveness considerations, this technology will not be retained for further consideration.

3.4 SUMMARY OF REMEDIAL PROCESS OPTIONS AND SELECTION OF REPRESENTATIVE PROCESS OPTIONS

This subsection presents a summary of those technologies evaluated in Subsection 3.3, and identifies those technologies selected as representative process options. Selection of representative process options is performed to simplify the subsequent development and evaluation of alternatives (Section 4), without limiting the flexibility during remedial design. The representative process option provides a basis for developing performance, implementation, and cost information during detailed analysis of alternatives. The specific process actually used to implement the remedial action at the site may not be selected until the remedial design phase, or until the results of bench- or pilot-scale testing are available. In some cases, more than one representative process option may be selected for a technology type. This is done if two processes are sufficiently different from each other that one would not adequately represent the other.

The summary of technologies and selection of the representative process options are presented on Tables 3-3 and 3-4.

Table 3-3

Evaluation of Groundwater and Surface Water Technologies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost (1)	Recommendation
No Action	N/A	N/A	N/A	» Does not reduce toxicity,mobility,or volume (TMV) except for natural biodegradation and attenuation that may take place.	Low	Retain as required by the NCP.
Limited Action	Institutional actions	Deed restrictions	» Widely used form of limited action. » No implementation difficulties expected.	» Reduced contact with target compounds expected. » No reduction in TMV expect by natural mechanisms.	Low	Retain
	Monitoring	Groundwater monitoring	» Conventional technology. » Widely used as part of limited action and other alternatives.	» No reduction in TMV expect by natural mechanisms. » Provides a warning mechanism if site conditions change.	Low	Retain
		Surface water monitoring	» Conventional technology. » Widely used as part of limited action and other alternatives.	» No reduction in TMV expect by natural mechanisms. » Provides a warning mechanism if site conditions change.	Low	Retain
Groundwater collection/containment	Pumping	Extraction wells	» Conventional technology; widely used for groundwater remediation. » Currently used at the site. » Elevated concentration and DNAPL presence may require special equipment.	» Control migration of the target compounds. » Provides mechanism to transport groundwater to a treatment system. » Limited effectiveness in removing DNAPLs.	Low to Moderate	Retain
		Product recovery	»Conventional technology. » Can be used in conjunction with extraction wells.	» May be effective in removal of DNAPLs.	Low to Moderate	Retain
	Vertical barriers	Slurry walls	» Conventional technology. » Practical depth limitation of ~25'; only applicable to portions of the site.	» Prevents migration of target compounds. » Can be used to divert groundwater towards collection systems.	Moderate	Retain
		Interceptor trenches	» Conventional technology. » Practical depth limitation of ~25'; only applicable to portions of the site.	» Prevents migration of target compounds. » Actively collects contaminated groundwater for treatment.	High (Capital) Low (O&M)	Retain

Table 3-5 (cont'd)

Evaluation of Groundwater and Surface Water Technologies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost (1)	Recommendation
Surface water collection/containment	Diversion	Grading	» Conventional technology employing heavy equipment. » Not possible in parts of plant area where plant structures exist.	» Prevents migration of target compounds. » Can be used in conjunction with other treatment/collection technologies. » Significant impacts to natural wetlands may occur if implemented in these areas.	Moderate	Retain
		Dikes/berms/swales	» Conventional technology. » Implementable in many of the confined areas of the plant. » Implementation possible in wetlands area.	» Prevents migration of target compounds. » Can be used in conjunction with other treatment/collection technologies.	Moderate	Retain
	Collection	Surface sumps/pumps	» Conventional technology. » Implementation possible in both plant and other areas.	» Prevents migration of target compounds. » Collected surface water could be transported for treatment.	Moderate	Retain
		~~Sedimentation basins/ponds~~	~~» Conventional technology.~~ ~~» Currently in use at the site.~~ ~~» Would require additional space for placement of the basin; may not be possible.~~	~~» Prevents migration of the non-suspended target compounds.~~ ~~» Further treatment of the effluent, collected sediments could be required prior to discharge.~~	~~High~~	~~Do not Retain~~
Treatment	Biological treatment	Aerobic/Anaerobic	» Conventional technology for many organic compounds. » Aerobic or anaerobic conditions must be maintained. » Treatability testing is required. » Available land space is required.	» High concentration may cause problems (microbial inhibition). » Anaerobic/aerobic steps required for reduction below response levels; may be difficult to achieve.	Moderate to High	Retain
	Chemical/physical	Air/steam stripping	» Conventional technology. » Currently in use at the site. » Vapor control system is required. » Minimal space requirements.	» Demonstrated at the site to remove the target compounds from liquid phase. » Destruction of the target compounds utilizing the current vapor control system.	Low to Moderate	Retain (2)

Table 3-3 (cont'd)

Evaluation of Groundwater and Surface Water Technologies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost (1)	Recommendation
		Carbon adsorbtion	» Conventional technology. » Applicable to both liquid and vapor phase waste streams. » Requires disposal/regeneration of spent carbon; onsite regeneration of carbon is possible.	» Effective at removing target compounds in both liquid and vapor phase; high removal percentages expected. » May be used as a polishing technology in conjunction with other treatment technologies.	Moderate to High	Retain
		Advanced oxidation	» Bench and pilot scale testing would be required. » Turbidity of water would affect penetration of UV light (if used).	» Destruction of target compounds would be expected. » Subject to system upsets if characteristics of influent change.	Moderate to High	Retain
	~~Off-site treatment~~	~~RCRA facility~~	~~» Offsite facility requires proper permitting to accept waste stream.~~ ~~» Not practical for large volumes, or if large volumes are continuously generated unless a pipeline is used.~~	~~» Permitted facility would meet all applicable regulations and performance standards.~~ ~~» Reduction in TMV depends upon treatment technology employed at the facility.~~	~~High~~	~~Do not Retain~~
	In-situ treatment	~~Bioreclamation~~	~~» Geologic conditions must be favorable to extraction/reinjection of nutrients.~~ ~~» May be used in conjunction with extraction/reinjection of groundwater.~~ ~~» Treatability testing would be required.~~	~~» Discharge of nutrients to RLC must be controlled - nitrate, ammonia.~~ ~~» Required anaerobic/aerobic processes would be difficult to maintain.~~ ~~» Complete destruction would be difficult.~~ ~~» May effect treatment of contacted soils.~~	~~Moderate~~	~~Do not Retain~~
		~~Chemical reaction~~	~~» Geologic conditions must be favorable to extraction/reinjection of nutrients.~~ ~~» May be used in conjunction with extraction/reinjection of groundwater.~~ ~~» Treatability testing would be required.~~	~~» Discharge of oxidants to RLC must be controlled.~~ ~~» No significant treatment expected for DNAPLs.~~ ~~» May effect treatment of contacted soils.~~ ~~» Limited data on effectiveness.~~	~~Moderate to High~~	~~Retain~~

Table 3-3 (cont'd)

Evaluation of Groundwater and Surface Water Technologies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost (1)	Recommendation
Discharge	Onsite discharge	Local stream	» Pretreatment required. » Already is use at the site.	» Effectiveness of pretreatment process will govern any impacts due to a discharge to the local stream.	Low	Retain (2)
		GW injection	» Pretreatment required. » Effect of injection on groundwater extraction would have to be taken into account.	» Effectiveness of pretreatment process will govern any impacts due to a discharge back into the ground.	Low	Retain
Treatment using innovative technologies	Chemical/physical treatment	~~Evaporation/thermal stripping~~	~~» Requires high concentration of target compounds to be effective.~~ ~~» Can handle oils and heavy phases without fouling.~~	~~» May require a polishing treatment step.~~ ~~» Energy intensive technology.~~	~~Moderate to High~~	~~Do not Retain~~
		Adsorbtion using synthetics	» Bench and pilot scale testing would be required. » Disposal or regeneration of synthetic adsorbent would be required; may be possible onsite depending on the synthetic used.	» Effective at removing target compounds in both liquid and vapor phase; high removal percentages expected. » May be used as a polishing technology in conjunction with other treatment technologies.	Moderate to High	Retain

Footnotes:

(1) - Cost is relative to other process options of the same technology type. In the absence of other process options, cost is relative to other process options of the same general response action.
(2) - Process option selected as the "Representative Process Option" for given technology type.

Table 3-4

Evaluation of Soil and Sediment Remedial Technologies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost (1)	Recommendation
No Action	N/A	N/A	N/A	» Does not reduce toxicity,mobility,or volume (TMV) except for natural biodegradation and attentuation that may take place.	Low	Retain as required by the NCP.
Limited Action	Institutional actions	Deed restrictions	» Widely used form of limited action. » No implementation difficulties expected.	» Reduced contact with target compounds expected. » No reduction in TMV expect by natural mechanisms.	Low	Retain
	Security	Fencing	» Widely used form of limited action. » Existing site fence can be expanded/modified to encompass additional areas.	» Reduced contact with target compounds expected. » No reduction in TMV expect by natural mechanisms.	Low	Retain
	Monitoring	Wetlands monitoring	» Widely used form of limited action. » Conventional inspection techniques employed.	» Monitoring serves indicator of possible changes in site conditions. » No reduction in TMV expect by natural mechanisms.	Low	Retain
Collection	Removal	Excavation	» Widely used technology employing conventional construction techniques. » Practical limit to depth of excavated areas. » Not implementable in process areas.	» Removes affected media for further treatment/storage/disposal.	Low	Retain
		Dredging	» Widely used technology employing conventional construction techniques. » Low productivity as compared to excavation. » Land-based dredging techniques would have to be used.	» Removes affected media for further treatment/storage/disposal. » Destruction of natural wetlands may occur. » Quantities of sediment may become suspended/dispersed into Red Lion Creek (RLC) during remediation.	Moderate to High	Retain

Table 3-4 (cont'd)

Evaluation of Soil and Sediment Remedial Technologies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost (1)	Recommendation
Containment	Cap	Soil covers	» Widely used technology employing conventional construction techniques. » Steep grades will add difficulty to design and implementation. » Implementation in wetland areas would adversely impact wetlands.	» Limits mobility of target compounds by controlling infiltration due to precipitation, and controls contaminant runoff. » Reduces direct contact with target compounds in surface soils.	Low	Retain
		Low permeability soil caps	» Same as soil covers; more effort required for design and implementation.	» Same as soil covers, but more effective at reducing infiltration.	Low to Moderate	Retain (2)
		Synthetic membrane liners	» Same as low permeability soil caps; more effort required for design and implementation.	» Same as low permeability soil caps, but more effective at reducing infiltration. Properly designed and installed synthetic membrane liner systems are virtually impervious to infiltration.	Moderate to High	Retain
		Asphalt/concrete caps	» Same as soil covers.	» Limits mobility of target compounds as with other caps. » Reduces direct contact with target compounds in surface soils. » No associated erosion problems. » Subject to cracking/deterioration over extended periods of time.	Moderate to High	Retain
	Sediment barriers	~~Geofabrics/erosion mats~~	~~» Geofabrics are available from several vendors, although specific material for this type of application was not identified.~~ ~~» Application would damage natural wetlands (e.g. scrubbing).~~ ~~» Regrowth of wetlands vegetation may destroy geofabric.~~	~~» May further reduce erosional mobility of target compounds in the sediments.~~ ~~» May have adverse impacts to wetland areas.~~ ~~» Term reliability is not yet proven.~~	~~Moderate~~	~~Do not Retain~~
		Aggregate materials	» Use of conventional materials and installation techniques. » Maintenance/monitoring of drainage pathways required due to erosion, changes in flow path.	» Reduces erosional mobility of target compounds in sediments. » Changes in drainage pathways may have adverse effects on wetlands.	Low	Retain

• Table 3-4 (cont'd)

Evaluation of Soil and Sediment Remedial Technologies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost (1)	Recommendation
Treatment	Thermal treatment	Incineration	» Widely accepted technology for the destruction of organic compounds. » Mobile and stationary units are commercially available. » Pretreatment or modification of waste feed system may be required to accept high moisture contents wastes. » Energy intensive technology. » Poor public perception of incineration.	» Demonstrated, permanent treatment solution (99.99% DRE req'd by RCRA). » Air emissions controls required during treatment. » Treatment residuals may be backfilled after treatment and delisting.	High	Retain
		Thermal desorption	» Emerging technology for treatment of volatile/semivolatile organic compounds. » Transportable unit available. » Pretreatment or modification of waste feed system would be required to accept high moisture content materials. » Less energy intensive than incineration due to reduced operating temperatures.	» Permanent treatment solution; lab-scale treatability test showed 99.9-99.999% DRE on materials from the site. » Air emission controls would be required. » Treatment residuals could be backfilled after treatment and delisting. » Recovery of target compounds could be used by the facility.	Moderate to High	Retain (2)
	Chemical treatment	~~Dechlorination~~	~~» Commercial systems are available~~ ~~» Difficult to determine correct stoichiometry for heterogeneous feed.~~	~~» Demonstrated (field-scale) dechlorination of chlorinated aromatic hydrocarbons.~~ ~~» Toxicity of treatment residuals may cause further treatment to be necessary.~~	~~Moderate to High~~	~~Do not Retain~~
	Physical treatment	Stabilization/solidification	» Conventional technology for ex situ application » Technology can be potentially implemented in situ. » Lab scale testing would be required to identify proper stabilizer. » Can be used as a finish treatment step.	» Reduction in mobility of target compounds would be expected. » Difficult to measure effectiveness if performed in situ; heterogeneity of treatment is problematic. » Leachability of treated material is problematic.	Low to Moderate	Retain

Table 3-4 (cont'd)

Evaluation of Soil and Sediment Remedial Technologies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost (1)	Recommendation
		~~Solvent rinsing/soil washing~~	~~» Emerging technology with proprietary processes available.~~ ~~» May be impractical for high concentration materials because multiple rinses would be required.~~	~~» Removal efficiencies are dependant on the solvent used; may be only 90%.~~ ~~» Treatment residuals (fines) requiring further treatment may be substantial.~~ ~~» Treatment residuals (coarse soils) may be unacceptable for backfill.~~	~~Low to Moderate~~	~~Do not Retain~~
	Biological treatment	Solid phase	» Conventional technology for some organic compounds. » Performed as an ex situ, batch process. » Anaerobic/aerobic stages would be required. » Lab and pilot scale treatability studies would be required. » Minimal pretreatment required.	» Relatively slow rate process; extended cleanup period. » Little prior data concerning effectiveness exists; no full-scale implementations documented for chlorobenzenes. » Reaction kinetics problematic; incomplete dechlorination during anaerobic stage.	Low to Moderate	Retain
		Slurry phase	» Emerging technology. » Batch or continuous process is possible. » Lab and pilot scale treatability would be required.	» Additional pre or post treatment may be required. » Relatively high reaction rate process (compared to solid phase). » Effectiveness problems would be similar to solid phase treatment. » Aqueous phase management would be required.	Moderate	Retain
	Off-site treatment	RCRA TSD	» Numerous commercial facilities available. » Facility must be permitted to accept waste of this nature. » Eliminates problems of public perception of onsite treatment.	» An acceptable, permitted facility must meet all applicable treatment/disposal standards.	High	Retain

Table 3-4 (cont'd)

Evaluation of Soil and Sediment Remedial Technologies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost (1)	Recommendation
In-situ treatment	Thermal treatment	~~In-situ vitrification~~	~~» Not applicable to process areas.~~ ~~» Technology not currently available due to investigations into a fire that occurred during a treatment demonstration.~~ ~~» Not applicable to areas of high moisture content.~~	~~» Thermal desorbtion/destruction of volatile and semivolatile organics.~~ ~~» Those compounds not desorbed/destroyed are held immobile in a vitrified matrix.~~	High	~~Do not Retain~~
	Biological treatment	In-situ biodegradation	» Geologic conditions must be favorable to extraction/reinjection of nutrients. » Very difficult to maintain anaerobic then aerobic conditions in areas of treatment. » Difficult to quantify successful treatment; preferential treatment zones may exist.	» Destruction/dechlorination of target compounds. » Little prior data concerning effectiveness exists; no full-scale implementations documented for chlorobenzenes. » Materials not extracted could have adverse effect on wetlands.	Moderate to High	Retain
	Physical treatment	~~Soil flushing~~	~~» Geologic conditions must be favorable to extraction/injection of solvents.~~ ~~» Injection and extraction wells use conventional construction techniques.~~	~~» High soil/water sorbtion coefficient will limit effectiveness when using H2O as solvent.~~ ~~» Use of solvent other that H2O may jeopardize confining unit.~~ ~~» Effectiveness will be variable, and difficult to measure.~~	~~Moderate to~~ High	~~Do not Retain~~
		~~In-situ steam/hot air injection with vapor extraction~~	~~» Emerging technology.~~ ~~» Access restrictions due to existing plant equipment limits placement of extraction/injection vents, although less restrictive than technologies involving excavation.~~ ~~» May be an energy intensive technology.~~ » Lab and pilot scale testing would be required. » In situ treatment minimizes disruptions to plant operations.	~~» Soil conditions favorable for large radius of influence.~~ ~~» Heat input may mobilize (but not capture) semivolatile compounds within soils resulting in downward migration of contaminants.~~ ~~» Low volatility makes effectiveness of vapor extraction suspect.~~ » Formation of non-aqueous phase liquids (condensation) may be problematic.	~~Moderate to~~ High	~~No not Retain~~

Table 3-4 (cont'd)

Evaluation of Soil and Sediment Remedial Technologies
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost (1)	Recommendation
Disposal	Landfilling	Onsite or Offsite Secure (RCRA) landfill	» Conventional technology. » Requires available space; may not be available on site property. » Pretreatment of RCRA hazardous materials may be required. » Long-term monitoring and maintenance required.	» Reduces mobility of target compounds. » Limits direct exposure to target compounds. » Reduction in volume of materials onsite if offsite facility used.	Moderate to High	Retain
Treatment using innovation technologies	Chemical treatment	~~Nascent state hydrodechlorination~~	~~» Dechlorination technology in its infancy state.~~ ~~» Application of technology limited to laboratory-scale experiments.~~	~~» If dechlorination is successful, the byproduct of chlorobenzene dechlorination would be benzene, a more toxic compound.~~	~~Moderate~~	~~Do not Retain~~
		~~Advanced oxidation~~	~~» Generally used for water treatment; application to soils treatment is emerging.~~ ~~» Solid phase or slurry phase treatment may be possible.~~ ~~» Batch or continuous process is possible.~~ ~~» Treatability studies would be required.~~	~~» Successful treatment would result in destruction of target compounds.~~ ~~» Limited data concerning effectiveness exists.~~	~~Moderate to High~~	~~Do not Retain~~
	Biological treatment	Reductive dechlorination	» Can be performed in liquid or solid phase. » Anaerobic conditions must be maintained. » Treatability testing would be required.	» Limited data concerning effectiveness. » Slow rate process. » Toxicity of treatment residuals must be evaluated, potential benzene production. » May be able to destroy benzene ring. » Effectiveness problems same as for other biological treatment.	Moderate	Retain
		~~Plant uptake~~	~~» Application of vegetative species to wetlands should not adversely affect natural wetlands.~~ ~~» Monitoring and maintenance of uptake species would be required.~~ ~~» Treatability studies would be required.~~	~~» Toxicity of the byproducts of uptake must be considered.~~ ~~» Limited data concerning effectiveness exists.~~	~~Low~~	~~Do not Retain~~

Footnotes:

(1) - Cost is relative to other process options of the same technology type. In the absence of other process options, cost is relative to other process options of the same general response action.

(2) - Process option selected as the "Representative Process Option" for given technology type.

3.5 VOLUMES ESTIMATES

An estimate of the volume of materials exceeding response levels (Subsection 2.3) is presented on Table 3-5. Surface soils in the railroad track area, western drainage gulley, and eastern drainage ditch are defined as including soils to a depth of 3 feet. Three (3) feet is typically used during risk assessment to define surface soils. This is appropriate to use at this site because the response levels for surface soils are risk-based. Subsurface soils for the western drainage ditch, the eastern drainage gulley, and the CB1 have been delineated as follows:

- Western Drainage Gulley - Subsurface soils in the western drainage gulley include those soils that exceed 625 mg/kg total SCD target analytes (response level for on-site surface soils) to maximum specified depth of 7 feet below ground surface (bgs). Seven (7) feet bgs is specified for several reasons. First, samples collected from below 7 feet along the 1986 release pathway (which includes the western drainage gulley) had concentrations less than 625 mg/kg total SCD target analytes. Second, the intent of subsurface soil treatment is to remediate those subsurface soils that can be removed by open excavation techniques (e.g., without sheeting or shoring). Because there are no geotechnical borings in this area, the feasibility of excavating to a depth of 7 feet without sheeting or shoring will require evaluation during remedial design. It is assumed in this FS that approximately 50 percent of the western drainage gulley will require subsurface excavation.

- Catch Basin No. 1 - In the CB1 area, excavations will not proceed beyond the depth of the basin (approximately 15 feet) to protect the basin's structural integrity. The areal extent of contamination around CB1 is assumed to be approximately 75 feet by 75 feet.

- Eastern Drainage Ditch - Subsurface soil remediation along the eastern drainage ditch is not necessary based on samples collected in this area (i.e., no samples greater than 625 mg/kg total SCD target analytes below three feet).

The areas exceeding response levels are presented on Figure 3-1.

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Table 3-5

Area and Volume Estimates
Standard Chlorine of Delaware, Inc.

Site	Area (sq ft)	Depth (ft)	Volume[a] (cy)
1. Railroad Track Area			
a. 1986 Release	36,050	3	4,400
b. 1981 Release	1,260	3	150
2. Western Drainage Gully			
a. Surface Soils	12,600	3	1,550
b. Subsurface Soils	6,300	3-7	1,000
3. Eastern Drainage Ditch	2,750	3	350
4. Soil Piles (2)	---	---	4,700[b]
- Plus 2 ft soil removal beneath piles	16,000	2	1,200
5. Sedimentation Basin[c]			
- Existing Sediment in Basin	---	---	3,350
6. Wetlands			
a. Northern Portion of Unnamed Tributary (Area A)	271,000	1	11,000
b. Confluence of Drainage Gully and Unnamed Tributary (Area B)	23,165	1	950
c. Sample SST-31 Area	700	1	25
d. Sample SD-4 Area	700	1	25
7. Catch Basin	6,000		3,700
TOTALS	370,225 sq ft		32,400 cy

Notes:

[a]Volume (cy) = 1.10 [Area (sq ft) x Depth (ft)] / [27 ft^3/cy]. 1.10 represents a 10% over-excavation factor.

[b]Volume of soil piles provided by Standard Chlorine of Delaware.

[c]Total capacity of sedimentation basin (to ground surface) is 17,800 cy, which includes the volume of existing sediment in the basin.

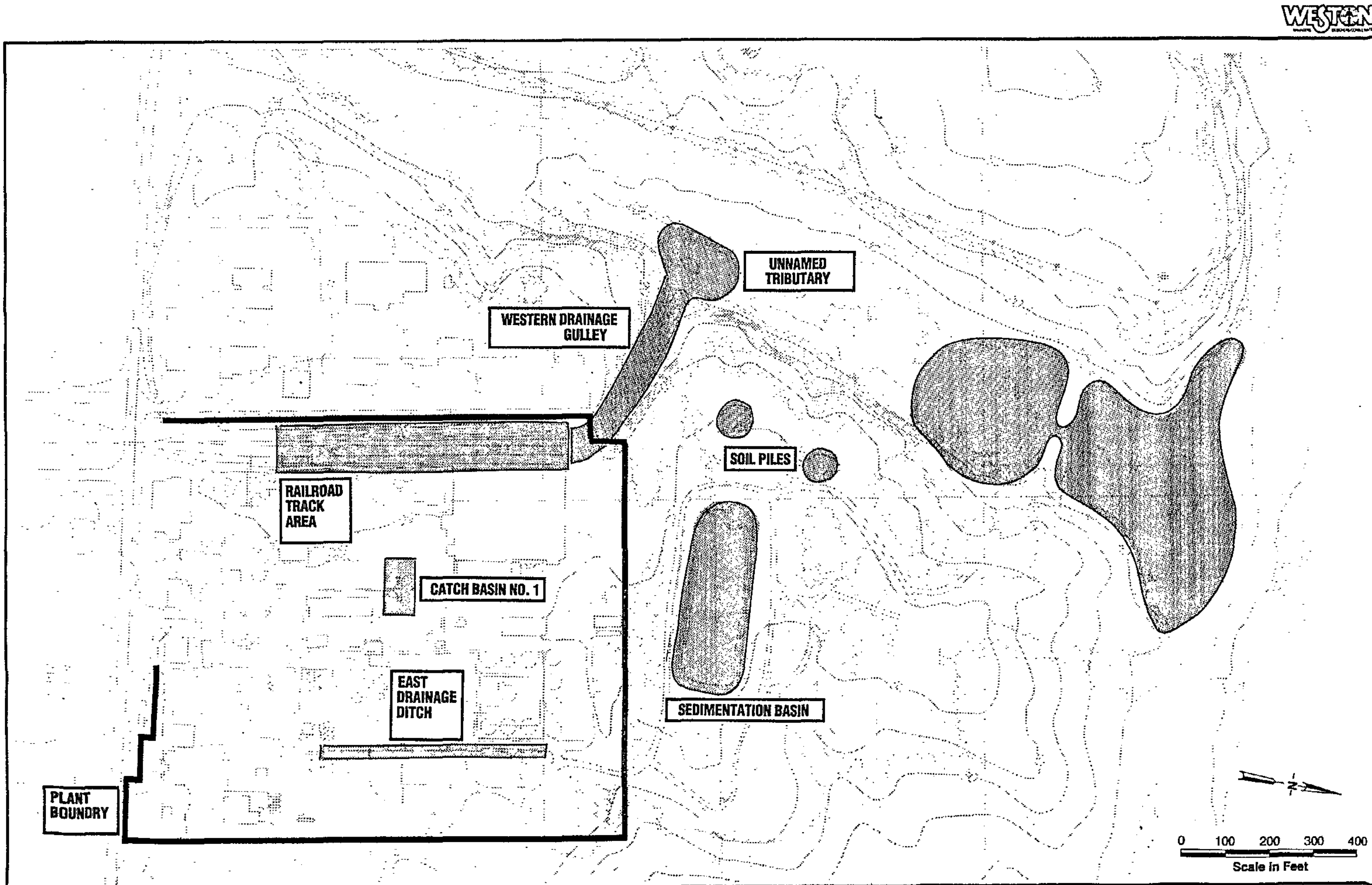

FIGURE 3-1 LOCATION OF SURFACE SOIL AND SEDIMENTS EXCEEDING RESPONSE LEVELS

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SECTION 4

DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

4.1 INTRODUCTION

Remedial alternatives were formulated to address the contamination associated with the site. Section 3, provided a preliminary evaluation of potential remedial action technology types, and evaluated the process options of each technology type based on implementability, effectiveness, and relative cost. In this section, the representative process options presented in Subsection 3.4, are combined to form site-wide (covering all media of concern) alternatives.

Subsection 4.2 presents the rationale for developing site-wide remedial action alternatives, and describes each alternative developed. Subsection 4.3 presents the methodology for screening the potential remedial alternatives, and the results of the screening for each alternative. Subsection 4.4 presents a summary of the development and screening of alternatives, and identifies those alternatives that will be carried into the detailed analysis of alternatives.

4.2 DEVELOPMENT OF ALTERNATIVES

The purpose of the alternative development process is to produce remedial action alternatives that provide a range of approaches and effectiveness. Therefore, the alternatives vary in the degree of remediation they provide. The NCP (40 CFR 300.430) identifies a range of alternative cateogories that should be developed. These categories include:

- Alternatives that protect human health and the environment by recycling waste or by eliminating, reducing, and/or controlling risks posed through each pathway by a site.
- Alternatives in which treatment that reduces the toxicity, mobility, or volume of contaminants is the principal element.
- Alternatives that involve little or no treatment.

- Alternatives that attain site-specific remediation levels within different restoration time periods.

- Alternatives using innovative technologies, if those technologies offer the potential for comparable or superior performance.

- The no action alternative.

These categories and the remedial action objectives (as presented in Section 2) are applied, wherever applicable, to each media of concern at the site in the following subsections to develop potential remedial action alternatives.

4.2.1 Remedial Alternatives for Soils

Soils, as described in this subsection, include onsite and offsite surface soils, and the soils contained in the soil piles. The general response actions incorporated into the development of remedial alternatives for soils are as follows:

- No action.
- Limited Action.
- Containment.
- Collection.
- Treatment (in situ and ex situ).
- Offsite Disposal.

The alternatives developed for soils are presented on Table 4-1.

4.2.2 Remedial Alternatives for Sediments

Sediments include the sediments identified for remedial action in the unnamed tributary and Red Lion Creek, and the sediments that were previously removed from the unnamed tributary during emergency response actions and are contained within the sedimentation basin. The general response actions incorporated into the development of remedial alternatives for sediments are as follows:

- No action.
- Limited Action.
- Containment.
- Collection.

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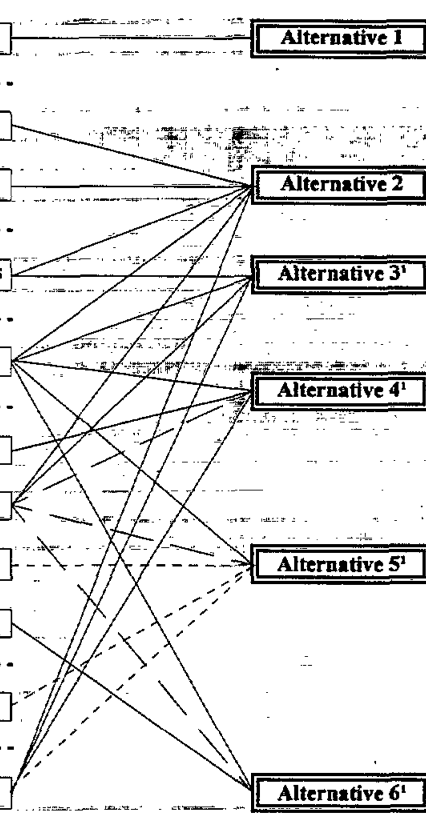
TABLE 4-1

Development of Soil Alternatives
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Retained Representative Process Option
No Action	N/A	N/A
Limited Action	Institutional actions	Deed restrictions
	Security	Fencing
Containment	Cap	Low permeability soil caps
Collection	Removal	Excavation
Treatment	Thermal treatment	Thermal desorbtion
	Physical treatment	Stabilization/solidification
	Biological treatment	Solid Phase
	Offsite treatment	Offsite RCRA Facility
In-situ treatment	Biological treatment	In-situ biodegradation
Disposal	Landfilling	Onsite Landfill
Treatment using innovation technologies	Thermal treatment	X-TRAX [2] (represented by thermal desorbtion)
	Biological treatment	Reductive dechlorination [2] (represented by solid phase biological treatment)

Alternative



NOTES:
——— Planned remedial activity.
— — May be necessary as part of a remedial alternative.
- - - - Implemented as an option to a remedial alternative.
[1] Deed restriction and fencing are also included in Alternatives 3, 4, 5, and 6.
[2] X-TRAX and reductive dechlorination are sufficiently similar to thermal desorption and solid phase biological treatment, respectively. These technologies could be substituted during remedial design.

- Treatment.
- Offsite Disposal.

Alternatives developed for sediments are presented on Table 4-2.

4.2.3 Remedial Alternatives for Groundwater

The general response actions incorporated into the development of remedial alternatives for groundwater are as follows:

- No action.
- Limited Action.
- Collection/Containment.
- Treatment.
- Discharge.

The alternatives developed for groundwater are presented on Table 4-3.

4.2.4 Remedial Alternatives for Surface Water

The concentrations of contaminants were generally below response levels in surface water. In addition, remedial efforts in the other media at the site are expected to improve the quality of the surface water contained in the unnamed tributary and Red Lion Creek. Therefore, direct treatment of the surface water contained in these bodies is not warranted. The general response actions incorporated into the development of remedial alternatives for surface water are as follows:

- No action.
- Limited Action.
- Collection/Containment (covered under surface soil remedial alternatives).

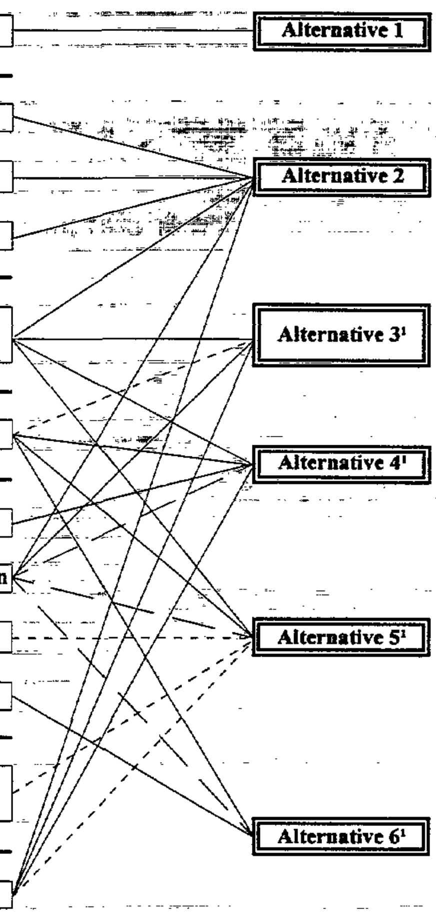
The alternatives developed for surface water are presented on Table 4-4.

TABLE 4-2

Development of Sediment Alternatives
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Representative Process Option
No Action	N/A	N/A
Limited Action	Institutional	Deed restrictions
	Security	Fencing
	Monitoring	Wetlands monitoring
Containment	Sediment barriers	Aggregate materials, silt fences
Collection	Removal	Dredging
Treatment	Thermal	Thermal desorbtion
	Physical	Stabilization/solidification
	Biological	Solid phase
	Offsite	Offsite RCRA Facility
In-situ treatment	Biological treatment	In-situ biodegradation
Disposal	Landfilling	Onsite Landfill
Treatment using innovation technologies	Thermal treatment	X-TRAX[2] (represented by thermal desorbtion)
	Biological treatment	Reductive dechlorination[2] (represented by solid phase biological treatment)

Alternative



NOTES:

——— Planned remedial activity.

— — — May be necessary as part of a remedial alternative.

- - - - - May be part of a remedial alternative.

[1] Deed restrictions, fencing, and monitoring are also included in Alternatives 3, 4, 5, and 6.

[2] X-TRAX and reductive dechlorination are sufficiently similar to thermal desorption and solid phase biological treatment, respectively. These technologies could be substituted during remedial design.

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TABLE 4-3

Development of Groundwater Alternatives
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Retained Representative Process Option	Alternative
No Action	N/A	N/A	Alternative 1
Limited Action	Institutional actions	Deed restrictions	
	Monitoring	Groundwater monitoring	Alternative 2
Groundwater collection/containment	Pumping	Extraction wells	
		Product recovery	Alternative 3[1]
	Vertical barriers	Slurry walls	
		Interceptor trenches	Alternatives 4 - 6[1]
Treatment	Biological treatment	Aerobic/Anaerobic	
	Chemical/physical	Air/steam stripping	
		Carbon Adsorbtion	May be applicable as a component to another alternative.
Discharge	Onsite discharge	Local stream	
Treatment using innovative technologies	Chemical/physical treatment	Adsorbtion using synthetics[2] (represented by carbon adsorbtion)	

NOTES:

——— Planned remedial activity.

- - - - - May be part of a remedial alternative.

[1] Deed restriction and monitoring are also included in Alternatives 3, 4, 5, and 6.

[2] Adsorbtion using synthetics is sufficiently similar to carbon adsorbtion. This technology could be substituted during remedial design.

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TABLE 4-4

Development of Surface Water Alternatives
Standard Chlorine of Delaware, Inc.

General Response Action	Technology Type	Retained Representative Process Option	Alternative
No Action	N/A	N/A	Alternative 1
Limited Action	Institutional actions	Deed restrictions	Alternatives 2 - 6
	Monitoring	Groundwater monitoring	
		Surface water monitoring	Alternatives 2 - 6
Surface water collection/containment	Diversion	Grading	Alternatives 2 - 6
		Dikes/berms/swale	Alternatives 2 - 6
	Collection	Surface sumps/pumps	Alternatives 2 - 6

Runon and runoff controls to be covered under surface soil remedial alternatives.

NOTES:
——— Planned remedial activity.

4.2.5 Site-Wide Alternatives Assembly

In the previous subsections, the technologies employed by the remedial alternatives for each media have been presented. In this section, those alternatives are assembled into site-wide alternatives, addressing all media at the site.

In the descriptions of alternatives that follow, specific terminology is used to describe the media that the remedial actions are being applied to. The following clarifies some of these terms:

- "Surface soils" - For the purposes of this FS, surface soils are defined as those soils to a depth not exceeding three (3) feet. Because the response levels are risk-based, this depth is used to be consistent with the definition of surface soils used during risk assessment.

- "Selected subsurface soils" - Includes subsurface soils in the western drainage gulley, and in the vicinity of CB1. Selected subsurface soils in these areas includes soils that exceed 625 mg/kg (based on the surface soil response level), and a maximum depth of 7 feet. Samples collected from below 7 feet along the 1986 release pathway (which includes the western drainage gulley) had concentrations less than 625 mg/kg. The intent of subsurface soil excavations is to perform the open-excavations (e.g., without sheeting or shoring). Because there are no geotechnical borings in this area, the feasibility of excavating to a depth of 7 feet will require evaluation during remedial design. In the CB1 area, excavations will not proceed beyond the depth of the basin (15 feet) to protect the basin's structural integrity. Because the railroad track area is vital to plant operations and cannot be excavated, an ashpalt cap will be placed in this area. Subsurface soil excavation along the eastern drainage ditch is not necessary based on samples collected in this area (i.e., no samples greater than 625 mg/kg below three feet).

- "Readily accessible, highly contaminated surface soils" - Readily accessible, highly contaminated soils refers to those soils that are 1) accessible without moving plant equipment (does not include the railroad track area), and 2) exhibit a high concentration of contaminants. Areas containing soils of high concentration refers to those areas where materials exceed response levels. For example, the soil piles are considered readily accessible, highly contaminated surface soils.

- "Readily accessible, highly contaminated sediments" - Readily accessible, highly contaminated sediments refers to those sediments that 1) are accessible for removal to conventional excavation equipment (e.g., long-reach track-hoes) from the shoreline, and 2) exhibit a high concentration of contaminants. Areas containing sediments of high concentration refers to those areas where materials exceed response levels. For example, the seeps along the unnamed tributary are considered readily accessible, highly contaminated sediments.

A brief description of each alternative follows.

4.2.5.1 Description of Site-Wide Alternative

Alternative 1 - No Action -This is the no action alternative as required by the NCP. Under this alternative, no additional measures would be implemented to mitigate existing conditions at the site. Current remedial activities, such as groundwater extraction and treatment, would cease.

Alternative 2 - Containment - This alternatives would provide source remediation for the media posing the greatest environmental impact. Institutional controls, site security and site monitoring would be implemented. The readily accessible, highly contaminated surface soils and sediments would be remediated. Surface soils would be removed and stabilized/solidified in situ in the sedimentation basin, while sediments would be further contained by installing additional silt fences. Selected subsurface soils along the western drainage gulley, and subsurface soils in the vicinity of CB1 would also be excavated. The excavations would be backfilled and completed with a cap system that includes a flexible membrane liner (FML) or asphalt to function as an infiltration barrier for deeper soils. The railroad track area will be covered with an asphalt cap. The sedimentation basin would be capped after consolidation. Existing groundwater remediation efforts would be augmented by additional groundwater extraction wells to reduce the flux of contaminants leaving the site. Product recovery wells would be installed to recover DNAPL.

Alternative 3 - Closure - This alternative provides for containment and closure of the media exceeding the response levels. Readily accessible, highly contaminated surface soils and sediments would be removed and stabilized (ex situ) prior to closure in the sedimentation basin. Selected subsurface soils along the western drainage gulley, and subsurface soils in the vicinity of CB1 would also be excavated. The excavations would be backfilled and completed with a cap system that includes a flexible membrane liner (FML) or asphalt to function as an infiltration barrier for deeper soils. The railroad track area will be covered with an asphalt cap. The sedimentation basin would be reconstructed with an new liner, leachate collection system. Soils and sediment would be stabilized and consolidated into the reconstructed basin and capped. The existing groundwater recovery and treatment system would be enhanced, through the use of an interceptor trench, to capture all groundwater leaving the site; air stripping would continue to be the primary groundwater treatment technology. Product recovery wells would be installed in an attempt to recover DNAPL. Institutional controls, site security, and site monitoring, as detailed under Alternative 2 would also be implemented where appropriate.

Alternative 4 - Thermal Treatment - Two options are included in this alternative (Options A and B). This alternative provides for treatment of soils, sediments and groundwater. The key actions proposed for each option are as follows:

Option A: The readily accessible, highly contaminated surface soils and sediments would be removed and treated using thermal desorption. Selected subsurface soils along the western drainage gulley and subsurface soils in the vicinity of CB1 would also be excavated and treated. The excavations would be backfilled (using treated soils) and completed with a cap system that includes an FML or asphalt. Treated sediments would be consolidated into the sedimentation basin. If these treated materials do not meet delisting criteria, the sedimentation basin would be reconstructed to include a new liner, leachate collection system, and multilayer cap. Stabilization/solidification would be performed if necessary. Caps would be placed over those soils above the response levels that are not excavated (i.e., the railroad track area). Groundwater recovery and treatment would be the same as for Alternative 3.

Option B: All soils and sediments described under Option A, and all sediments above the response levels would be removed and treated using thermal desorption. The railroad track area will be capped with asphalt. Treated soils would be used to backfill excavations, while treated sediments would be consolidated into the sedimentation basin. If these treated materials do not meet delisting criteria, the sedimentation basin would be reconstructed to include a new liner, leachate collection system, and multilayer cap. Stabilization/solidification would be performed if necessary. Groundwater recovery and treatment would be the same as for Alternative 3. Institutional controls, site security, and site monitoring, as detailed under Alternative 2 would also be implemented where appropriate.

Alternative 5 - Biological Treatment - Two options are included in this alternative (Options A and B). This alternative provides for treatment of soils, sediments, and groundwater. The key actions proposed for each option are as follows:

Option A: Actions planned for this alternative are the same as for Alternative 4, Option B with the exception that biological treatment is substituted for thermal treatment.

Option B: The biological treatment would be performed in situ. This would effect both surface and subsurface soils. Groundwater recovery and treatment would be the same as for Alternative 3. Institutional controls, site security, and site monitoring, as detailed under Alternative 2, would also be implemented where appropriate.

Alternative 6 - Offsite Disposal - This alternative provides for removal and offsite treatment and disposal of the solid media above the response levels. All surface soils and sediments above the response levels (with the exception of the railroad track area) would be removed and transported offsite for treatment and disposal. The railroad track area would be capped with asphalt. Offsite backfill would be used to fill the excavations if sufficient quantities of onsite backfill are not available. Groundwater recovery and treatment would be the same as for Alternative 4. Institutional controls, site security, and site monitoring, as detailed under Alternative 2 ,would also be implemented where appropriate.

4.3 SCREENING OF REMEDIAL ALTERNATIVES

In this section, remedial alternatives developed in Subsection 4.2 will be screened to reduce the number of alternatives that will undergo a more thorough analysis during the detailed analysis of remedial alternative (Section 5). When applicable, comparisons are made between alternatives to select only the most promising for further evaluation. It is intended that the alternatives selected for further analysis are representative, to the extent possible, of the categories of remediation as described by the NCP. The remedial alternatives are screened based on short- and long-term aspects of three criteria: implementability, effectiveness, and cost.

4.3.1 Alternative 1 - No Action

4.3.1.1 Implementability

This alternative involves no action and therefore would be readily implementable.

4.3.1.2 Effectiveness

This alternative does not provide any active means to reduce the toxicity, mobility, or volume (TMV) of contaminants at the site. Some natural attenuation of organics may occur over time, but the rate and extent of attenuation are difficult to predict. Because the existing remedial efforts would cease, it would be expected that mobility of the contaminants would increase, as the current barriers to their mobility (e.g., groundwater extraction, maintenance of the soil pile covers) are removed.

4.3.1.3 Cost

No cost is incurred from this alternative.

4.3.1.4 Recommendation

This alternative will be carried into the detailed analysis of alternatives.

4.3.2 Alternative 2 - Containment

4.3.2.1 Implementability

Implementation of institutional controls, site security, and site monitoring pose no technical difficulties for implementation. Site monitoring, some of which is currently preformed at the site, would continue using existing sample collection and analytical techniques. Implementation of deed restrictions for future groundwater use is administratively feasible, although administrative difficulties may arise from the enforcement of restricted use of the wetlands. It is difficult, without constant surveillance, to ensure conformance on the limitations of wetlands use. Posting warning signs at regular intervals will prevent accidental entry to the wetlands, but it will be difficult, even if fences are installed, to deter a persistent trespasser.

Removal of the readily accessible, highly contaminated surface soils would not be expected to pose significant technical difficulties. Removal of surface and accessible subsurface soils in the western drainage gulley and the eastern drainage ditch can be completed using conventional excavation techniques. Removal of subsurface soils in the vicinity of CB1 must be implemented carefully, as the integrity of the basin must be maintained during these activities. Careful implementation of in situ stabilization/solidification is also required because preservation of the existing liner in the sedimentation basin is essential to ensure maximum containment of the stabilized materials.

Installation of capping systems using FMLs or asphalt is not expected to pose significant technical difficulties. These materials are commonly used to provide a low permeability barrier to infiltration.

Installation of additional silt fences, along the eastern shoreline of the unnamed tributary is not expected to pose any technical difficulties. Silt fences have been successfully installed at the site; with no administrative or technical concerns noted.

Installation of additional groundwater extraction, and new product recovery wells poses no significant technical difficulties. Groundwater extraction wells have already been successfully installed at the site. Maintenance of these extraction wells may be demanding, as clogging of the well screens in the existing extraction wells has been a problem. The precise location and number of additional groundwater extraction, and new product recovery wells will need to be determined during the remedial design phase. Treatment of the recovered groundwater is also viable as demonstrated by the present treatment and NPDES discharge.

4.3.2.2 Effectiveness

This alternative focusses of reducing the contact to, and mobility of contaminants in soils and sediments. For groundwater, this alternative provides a reduction in the mobility and volume of contaminants. These aspects are further described in the following paragraphs.

Implementation of this alternative would reduce the exposure to the contaminants at the site in several ways. Deed restrictions, such as limitations on groundwater or wetlands use, limit direct exposure to site contaminants, and are commonly applied at sites, with their effectiveness related to how well they are enforced. Site security measures, such as security fences, also limit direct exposure to site contaminants. Site monitoring serves as notification of changes in site conditions, and allows decision-makers adequate opportunity to adjust remedial measures to changing site conditions.

Removal, consolidation, in situ stabilization, and capping of the readily accessible, highly contaminated surface soils into the sedimentation basin will reduce the direct exposure to these materials, and will reduce the source of contamination to groundwater. Removal, consolidation, in situ stabilization, and capping of subsurface soils in the western drainage gulley, eastern drainage ditch, and in the vicinity of CB1 will also reduce the source of contamination to groundwater, which in turn will reduce the flux of contaminants into the unnamed tributary and Red Lion Creek. Stabilization of the material in the basin is primarily directed toward improving load bearing strength to support the final cover. Stabilizing agents must be selected via treatability testing to meet this remdial design objective. Some chemical fixation may result, however it not the primary objective. The cap placed on the basin will further reduce the mobility of the contaminants by limiting the infiltration of precipitation through the consolidated materials.

The excavations left by the source removal action will be capped with an FML or asphalt capping system and graded to prevent surface water runon and runoff. This capping system will serve to limit the infiltration of surface waters (from precipitation) through subsurface soils that contain site contaminants. This will reduce subsurface soils as a continuing source for groundwater contamination, which in turn will limit the flux of contaminants into the unnamed tributary and Red Lion Creek.

Installation of additional groundwater extraction wells will be designed to reduce the flux of contaminants into the unnamed tributary and Red Lion Creek to reduce the impact to surface water quality. Product recovery wells will attempt to reduce the volume of free phase contaminants in groundwater. Use of product recovery wells to remove DNAPL has had very limited successes in the past. However, it will be attempted in area of the site where DNAPLs have been previously encountered.

During implementation of these alternatives, engineering controls will be utilized to limit the amount of airborne dust generated during construction activities, and contain surface water runoff. Exposure to workers will be limited by complying with activity-specific safety protocols during performance of remedial activities. Proper materials handling procedures, such as those employed during the emergency response efforts of 1986, will be employed to minimize exposure to the workers, plant personnel, and the public.

4.3.2.3 Cost

The cost of this alternative is expected to be relatively moderate. The more significant capital costs will include the soil/sediment removal, consolidation, and stabilization activities. Operating and maintenance (O&M) costs will be incurred for monitoring activities, and long term maintenance of the sedimentation basin cap.

4.3.2.4 Recommendation

This alternative will be retained for detailed analysis. This alternative focuses on addressing those materials that pose the greatest environmental risk. Further, this alternative may have the highest benefit/cost ratio.

4.3.3 Alternative 3 - Closure

4.3.3.1 Implementability

The technical and administrative considerations for implementation of institution controls, site security, and site monitoring are the same as described for Alternative 2.

Removal, consolidation, stabilization, and capping of the readily accessible, highly contaminated surface soils, and subsurface soils would be similar to that described for Alternative 2. Removal of the readily accessible, highly contaminated sediments could be accomplished using conventional excavation equipment. Some pretreatment of removed sediments may be required to reduce the water content of these materials. Ex situ implementation of stabilization/solidification must be accomplished in controlled areas on-site which must be carefully planned considering the limited availability of on-site space. Reconstruction of the sedimentation basin is not expected to pose significant technical difficulties provided the new liner and leachate collection system can be placed directly over the existing liner system.

Implementation consideration for the installation of capping system, and silt fences are the same as described for Alternative 2.

Enhancement of the existing groundwater extraction well remediation system with an interceptor trench is technically feasible. Methods to enhance the existing system would include the use of interceptor trench placed along the shoreline of the unnamed tributary and Red Lion Creek. Installation of the interceptor trench will be difficult due to the location (near the shorelines of the unnamed tributary and Red Lion Creek), but is technically achievable. The installation of product recovery wells is not expected to pose significant technical difficulties. Treatment of recovered groundwater is viable using a system similar to or the same as currently utilized.

4.3.3.2 Effectiveness

The long term effectiveness of this alternatives is achieved by two primary mechanisms: 1) the reduction of the mobility and volume of the site contaminants, and 2) the reduction in exposure to the site contaminants. These aspects are further described in the following paragraphs.

The use of institutional controls, and site security measures to reduce the potential exposure to site contaminants is the same as discussed for Alternative 2. In short, these mechanisms reduce exposure by limiting contact with site contaminants (i.e., through groundwater consumption, and physical contact).

The mobility of the contaminants in soils (both surface and subsurface) and sediments is reduced by consolidating and stabilizing the affected media into the reconstructed sedimentation basin. Stabilizing agents must be selected via treatability testing to improve the bearing strength of the soils/sediments to support a final cover. Reconstruction of the sedimentation basin will include an additional liner, a leachate collection system, and a cap minimize the quantity of leachate generated and will provide more effective capture of the leachate leaving the materials in the sedimentation basin. This control and reduction of leachate will have a positive effect on groundwater quality. The exposure to the contaminants is also reduced as a physical barrier (the cap) is placed between the contaminated soils and potential receptors. Sediment barriers in the unnamed tributary will also serve to limit migration of contaminants in the wetlands.

The excavations left by the source removal action will be completed with an FML or asphalt capping system and graded to prevent surface water runon and runoff. This capping system will serve to limit the infiltration of surface waters (from precipitation) through subsurface soils that contain site contaminants. This will reduce subsurface soils as a continuing source for groundwater contamination, which in turn will reduce the flux of contaminants into the unnamed tributary and Red Lion Creek.

The removal of the readily accessible, highly contaminated sediments along the shoreline of the unnamed tributary limits the migration of those contaminants into surface water. The seeps are currently discharging contaminants into the unnamed tributary and the surrounding sediments. Removal of these materials, in conjunction with groundwater containment in this area, will both remove this source of surface water contamination, and prevent reoccurrence of the seeps.

The enhancement of the groundwater remediation system should be able to effectively capture groundwater before entering the unnamed tributary and Red Lion Creek. This will effectively reduce the influx of contaminants into the unnamed tributary and Red Lion Creek.

The product recovery wells may remove some DNAPL in the area directly adjacent to the wells, although the effectiveness is limited. DNAPLs are suspected on top of the confining unit underlying the Columbia Formation and the DNAPL will occur in small localized pockets or globs. The product recovery wells will only collect the DNAPL globs within the zone of influence of the well.

During implementation of these alternatives, engineering controls will be utilized to limit the amount of airborne dust generated during construction activities, and contain surface water runoff. Exposure to workers will be limited by complying with activity-specific safety protocols during performance of remedial activities. Proper materials handling procedures, such as those employed during the emergency response efforts of 1986, will be employed to minimize exposure to the workers, plant personnel, and the public.

4.3.3.3 Cost

The cost of this alternative are expected to be relatively moderate. The capital costs will be higher than those for Alternative 2, as additional resources are required for construction activities. O&M costs will also be higher, as long term maintenance of the caps, interceptor trench, and sediment barriers will be necessary.

4.3.3.4 Recommendation

This alternative will be carried in the detailed analysis. The alternative will provide a method for containment of the soils and sediments at the site, while providing for groundwater containment and treatment.

4.3.4 Alternative 4 - Thermal Treatment

This alternative has two options, Option A and Option B. Both of these options focus on removal and thermal treatment of soils and sediments, while implementing an enhanced groundwater remediation strategy. The difference between the options is that more materials are removed under Option B than under Option A.

4.3.4.1 Implementability

Option A

Technical and administrative consideration for the implementation of institutional controls, site security, and site monitoring are the same as discussed for Alternative 2.

Implementation considerations for the removal of readily accessible, highly contaminated surface soils and sediments, capping, and ex situ stabilization/solidification are the same as those discussed for Alternative 3.

Implementation of thermal desorption of the excavated soils and sediments is technically feasible. A treatability study has already been performed on contaminated materials from the site (WESTON, 1986). The results of the study indicate that some pretreatment or mixing of the feed materials will be necessary to reduce the moisture content. Blending the high moisture content sediments with the low moisture content surface soils may provide the desired feed properties. Backfill of the treated soils into the excavations, and the treated sediments into the sedimentation basin should not pose significant implementation difficulties. Additional treatability work may be needed during remedial design to set final operating parameters and treatment objectives.

Technical and administrative consideration for the implementation of the enhanced groundwater extraction system (i.e., interceptor trench and product recovery wells) are the same as discussed for Alternative 2.

Option B

Implementation considerations discussed for Option A of this alternative would also apply to Option B.

Excavation of surface soils that exceed the response levels should not pose significant technical difficulties in most areas of the site.

Removal of surface soils underneath the railroad track area is not feasible. The railroads are an integral part of plant production, and cannot be taken out of service without shutting down the facility. The surface soils in this area are covered by railroad ballast, and therefore are not accessible for direct contact by potential receptors. An asphalt cap in this area is the best approach to minimize infiltration in this area.

Dredging of all the sediments above the response levels would be technically difficult, but possible. Significant disruption/disturbance to these wetland areas would occur during the excavation action. Removing these sediments will require the use of multiple dredging techniques depending on the water level in the area to be dredged. These techniques may include mechanical and hydraulic dredging. Once the materials are removed, dewatering the sediments may be necessary prior to treatment, requiring additional support facilities.

Because of the large volume of surface soils and sediments to be removed under this alternative, and the limited space available on-site, staging the materials prior to and after treatment will be difficult. A phased approach to remediation will need to be implemented. This approach would divide the site up into regions, and complete remediation in each region prior to addressing other regions. The logistics of this approach must consider the interactions between regions. For example, the northwestern drainage gulley (along the 1986 release pathway) would not be remediated until after the railroad track area remediation was completed because runoff from the railroad track area will transport contaminants to the drainage gulley.

4.3.4.2 Effectiveness

The options of this alternative provide long-term solutions for the soils, sediments and groundwater. The topics discussed in this subsection are applicable to both Options A and B, although Option B offers additional effectiveness over Option A because additional contaminated materials are removed and treated. The disturbance to the site wetland areas and necessary restoration must be considered with respect to the overall cost to benefit ratio.

Thermal treatment of the surface soils and sediment will provide a substantial reduction in the volume of contaminated materials. The results of the thermal desorption treatability study showed removal efficiencies of 99.93% to 99.999% after two passes through the system (WESTON, 1986). After treatment, leachability testing (TCLP) of the materials will ensure that the mobility of the contaminants is reduced sufficiently to permit backfill of these materials. If the leachability is too great, stabilization/solidification will be used to obtain the necessary characteristics. If treatment goals are achieved, clean backfill on-site may be viable without the use of liners or leachate collection in the sedimentation basin.

Effectiveness considerations for the enhanced groundwater remediation system are the same as discussed for Alternative 3.

4.3.4.3 Cost

The cost for both options of this alternative are expected to be relatively high. As indicated by the volume estimates (Subsection 3.5), there is a large volume of surface soils and sediments above the response levels, thus capital expenditures will be high. Groundwater remediation costs are expected to the same as Alternative 3.

4.3.4.4 Recommendation

Both options of this alternative will be carried into the detailed analysis. These options provide a permanent remedy for the surface soils and sediments, and implement an aggressive approach to groundwater remediation.

4.3.5 Alternative 5 - Biological Treatment

This alternative has two options, Option A and Option B, that implement biological treatment as a method to remove contaminants from soils and sediments, and implement the enhanced groundwater remediation strategy as identified in Alternative 3. The difference between the options is that Option A implements biological treatment ex situ, while Option B implements the biological treatment in situ.

4.3.5.1 Implementability

Implementation considerations concerning the removal of materials (as proposed under Option A), and enhancing the groundwater extraction and treatment system are the same as discussed for Alternative 4.

Implementation of ex situ (Option A) or in situ (Option B) biological treatment of the soils and sediments is technically feasible, although further study is necessary. To this end, a treatability study is currently being performed on contaminated materials from the site (WESTON, 1992). The study is further investigating the amenability of the soils to in situ treatment. The results of the study will be incorporated as an addendum to the FS upon completion of the study.

4.3.5.2 Effectiveness

This alternative provides a long term solution for the surface soils and sediments above the response levels. Effectiveness consideration concerning the enhanced groundwater remediation system are the same as discussed under Alternative 4.

Biological treatment of the surface soils and sediment will provide a reduction in the toxicity and/or volume of contaminated materials. Literature searches on biological treatment have indicated that anaerobic treatment may dechlorinate chlorinated benzenes, resulting in lower chlorinated compounds. Further treatment of the lower chlorinated benzenes, particularly monochlorobenzene, under aerobic conditions may mineralize the compounds. The literature indicates that biodegradation of chlorinated benzenes is promising but has not been demonstrated in the field. Laboratory treatability testing of on-site soils will indicate the potential for this technology and determine if it is viable and should be tested further to support a final decision.

After an ex situ treatment (Option A), leachability testing (TCLP) of the materials would be used to show that the mobility of the contaminants is reduced sufficiently to permit backfill of these materials. If the leachability is too great, stabilization/solidification will be used to obtain the necessary characteristics.

In situ biological treatment (Option B) would affect not only the surface soils, but also the underlying subsurface soils. Treatment of the subsurface soils reduces the source of contamination for groundwater in the long term. During the short-term, the concentration of contaminants in groundwater would be expected to increase, as contaminants are mobilized due to the introduction of additional water.

4.3.5.3 Cost

The cost for both options of this alternative is expected to be relatively moderate to high. As indicated by the volume estimates (Subsection 3.5), there is a large volume of surface soils and sediments with contaminant concentrations above the response levels. This cost is dependant on the method of biological treatment employed. In situ biological treatment (Option B) is xpected to have a substantial cost benefit over ex situ treatment (Option A), requiring less capital expenditures. Groundwater remediation costs are the same as Alternative 4.

4.3.5.4 Recommendation

Both options of this alternative will be carried into the detailed analysis. They may provide a permanent remedy for the surface soils and sediments, and implements an aggressive approach to groundwater remediation. Option B should additionally affect treatment of contaminated subsurface soils.

4.3.6 Alternative 6 - Off-Site Disposal

This alternative focusses on removal and offsite disposal of soils and sediments, while implementing an enhance groundwater remediation strategy.

.3.4.1 Implementability

Removal of the surface soils and sediments would pose the same implementation difficulties as discussed for Alternatives 4 and 5. Dewatering procedures would be necessary for the sediments prior to offsite transport. Implementation considerations for groundwater extraction and treatment would be the same as for Alternative 3.

Transportation of the removed materials is technically achievable, although the quantity of material would make this an immense undertaking. Assuming a density of 1.3 tons/yd^3, greater than 1,600 truck loads of material would be transported offsite. Railroad cars could be utilized instead of transport trucks. Dedicated access roads to staging areas would be required, as well as truck weighing facilities. Clean backfill would be needed to restore the excavated areas.

A treatment and disposal facility capable and willing to except the volume and type of materials ll be difficult to locate. Treatment of the materials prior to landfilling is also required due to LDR's, and therefore an acceptable facility must also have the capability to treat the materials.

4.3.4.2 Effectiveness

This alternative provides an effective means for removing the contaminated materials from the environment receptors. The short-term effectiveness is similar to Alternatives 4 and 5, but since treatment and disposal is taking place offsite, risks associated with these operations are realized at the treatment and disposal facility. There are also increased short-term risks due to material transportation to the treatment and disposal facility. Disruption of wetland areas due to excavation in these areas would be significant.

The long-term effectiveness of this alternative is in the reduction of the volume of contaminated materials contained at the site. Backfill of the excavations (including an FML or asphalt capping system) will further enhance the long-term effectiveness by decreasing infiltration through the subsurface soils.

4.3.4.3 Cost

The cost associated with this alternative is expected to be very high. Treatment and disposal costs for the surface soils and sediments alone would be expected to be $30,000,000 to $50,000,000.

4.3.4.4 Recommendation

This alternative will not be retained for detailed analysis. The difficulties associated with implementing this technology, along with the very high cost make this alternative impractical.

4.4 SUMMARY OF RETAINED ALTERNATIVES

The following alternatives will be retained for detailed analysis:

- Alternative 1.
- Alternative 2.
- Alternative 3.
- Alternative 4, Options A and B.
- Alternative 5, Option A and B.

A summary of these alternatives is presented on Table 4-5.

TABLE 4-5

Summary of Alternatives for Detailed Analysis
Standard Chlorine of Delaware, Inc.

MEDIA	ALTERATIVE 1 No Action	ALTERNATIVE 2 Containment	ALTERNATIVE 3 Closure	ALTERNATIVE 4 Thermal Treatment	ALTERNATIVE 5 Biological Treatment
Surface Soils[1]	No Action	- Institutional controls (deed restrictions). - Site security (fencing). - Remove readily accessible, highly contaminated surface soils. - Consolidate and contain removed materials in the sedimentation basin. - Stabilize/solidify (in situ) materials in basin. - Cap sedimentation basin after consolidation. - Asphalt cap in railroad track area. - Surface water controls as necessary.	- Institutional controls and site security (same as Alternative 2 where appropriate). - Remove readily accessible, highly contaminated surface soils. - Stabilize/solidify (ex situ) removed surface soils. - Consolidate and contain removed materials in the sedimentation basin. - Reconstruct sedimentation basin to include new liner, leachate collection system, and cap. - Asphalt cap in railroad track area. - Surface water controls as necessary.	Option A: - Institutional controls and site security (same as Alternative 2 where appropriate). - Remove readily accessible, highly contaminated surface soils. - Treat removed soils using thermal desorbtion. - Backfill treated soils into excavated areas. - Surface water controls as necessary. Option B: - All elements of Option A.	Option A: - Institutional controls and site security (same as Alternative 2 where appropriate). - Remove readily accessible, highly contaminated surface soils. - Treat removed soils using ex situ biological treatment. - Backfill treated soils into excavated areas. - Surface water controls as necessary. Option B: - In situ biological treatment of soils above response levels. - Surface water controls as necessary.

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TABLE [illegible] (Cont'd)

Summary of Alternatives for Detailed Analysis
Standard Chlorine of Delaware, Inc.

MEDIA	ALTERATIVE 1 No Action	ALTERNATIVE 2 Containment	ALTERNATIVE 3 Closure	ALTERNATIVE 4 Thermal Treatment	ALTERNATIVE 5 Biological Treatment
Subsurface Soils[2]	No Action	- Remove, consolidate, in situ stabilize, and contain subsurface soils (as described for surface soils). - Line excavations using an FML.	- Remove, consolidate, stabilize/solidify (ex situ), and contain subsurface soils (as described for surface soils).	<u>Option A:</u> - Remove, consolidate, thermally treat, and backfill subsurface soils (as described for surface soils). <u>Option B:</u> - All elements of Option A.	<u>Option A:</u> - Remove, consolidate, thermally treat, and backfill subsurface soils (as described for surface soils). <u>Option B:</u> - In situ biological treatment.

TABLE 4-5 (Cont'd)

Summary of Alternatives for Detailed Analysis
Standard Chlorine of Delaware, Inc.

MEDIA	ALTERATIVE 1 No Action	ALTERNATIVE 2 Containment	ALTERNATIVE 3 Closure	ALTERNATIVE 4 Thermal Treatment	ALTERNATIVE 5 Biological Treatment
Sediments[3]	No Action	- Institutional controls (deed restrictions). - Site monitoring. - Sediment barriers (silt fences, aggregate materials) to prevent sediment transport. - Consolidate sediments already in the basin with removed soils. - Stabilize/solidify (in situ) materials in basin. - Cap sedimentation basin after consolidation.	- Institutional controls (deed restrictions). - Site monitoring. - Sediment barriers (silt fences, aggregate materials) to prevent sediment transport. - Remove readily accessible, highly contaminated sediments. - Restore disturbed wetlands. - Remove materials from sedimentation basin for ex situ stabilization/ solidification. - Reconstruct sedimentation basin to include new liner, leachate collection system, and cap.	<u>Option A</u>: - Institutional controls (deed restrictions). - Site monitoring. - Remove readily accessible, highly contaminated sediments. - Restore disturbed wetlands. - Treat using thermal desorbtion. - Reconstruct sedimentation basin to include new liner, leachate collection system, and cap. - Consolidate treated sediments into reconstructed sedimentation basin. - Sediment barriers as necessary. <u>Option B</u>:	<u>Option A</u>: - Institutional controls (deed restrictions). - Site monitoring. - Remove readily accessible, highly contaminated sediments. - Restore disturbed wetlands. - Treat using ex situ biological treatment. - Reconstruct sedimentation basin to include new liner, leachate collection system, and cap. - Consolidate treated sediments into reconstructed sedimentation basin. - Sediment barriers as necessary.

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TABLE [illegible] (Cont'd)

Summary of Alternatives for Detailed Analysis
Standard Chlorine of Delaware, Inc.

MEDIA	ALTERATIVE 1 No Action	ALTERNATIVE 2 Containment	ALTERNATIVE 3 Closure	ALTERNATIVE 4 Thermal Treatment	ALTERNATIVE 5 Biological Treatment
Ground-water	No Action	- Institutional controls (deed restrictions). - Site monitoring. - Continue existing groundwater extraction and treatment program. - Additional extraction wells to reduce flux into surface water. - Product recovery wells. - Treatment using existing or modified groundwater treatment system (air stripping).	- Institutional controls (deed restrictions). - Site monitoring. - Enhance existing groundwater recovery system to contain all groundwater exiting site. Will include use of extraction wells and/or vertical barriers (interceptor trenches). - Product recovery wells. - Treatment using existing or modified groundwater treatment system (air stripping).	<u>Options A and B:</u> - Same as Alternative 3.	<u>Options A and B:</u> - Same as Alternative 3.

TABLE 4-5 (Cont'd)

Summary of Alternatives for Detailed Analysis
Standard Chlorine of Delaware, Inc.

MEDIA	ALTERATIVE 1 No Action	ALTERNATIVE 2 Containment	ALTERNATIVE 3 Closure	ALTERNATIVE 4 Thermal Treatment	ALTERNATIVE 5 Biological Treatment
Surface Water[4]	No Action	- Deed restrictions (impose restricted wetland use[5]).	- Same as Alternative 2	Same as Alternative 2.	Same as Alternative 2.

NOTES:
1) Surface soils include soils to a depth of 3 feet, and soils contained in the soil piles.
2) Subsurface soils include....
3) Sediments include sediments in the Unnamed Tributary and Red Lion Creek to a depth of 1-1/2 feet, and those sediments contained in the sedimentation basin.
4) Surface water encompasses surface waters contained in the Unnamed Tributary and Red Lion Creek. Other surface waters (such as runon and runoff in the plant area) are covered under surface soils.
5) Concentrations generally exceed response levels only in Unnamed Tributary. Remedial actions in other media (e.g. groundwater containment) are expected to improve surface water quality.